Life Science

Use and Population Assessment of the Kesagami Lake Walleye and Northern Pike Fishery

Kesagami Lake Provincial Park for 1994 and 1995

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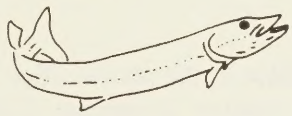

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This is the final report of the two year assessment program initiated by Ontario Parks and the Cochrane District office in 1994. Additional copies of this report are available at a cost of $35.00 including GST from the Ontario Ministry of Natural Resources at the following location: Park Superintendent, P.O. Box 730, 2 Third Ave., COCHRANE ON P0L 1C0. Cheques should be made payable to, Ministry of Natural Resources, Ontario Parks.

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INTRODUCTION

Northeastern Ontario supports a large remote recreational fishing industry for walleye (*Stizostedion vitreum*) and northern pike (*Esox lucius*). Kesagami Lake is one of the largest lakes in northeastern Ontario, is remote and protected within a provincial park. The lake is accessible from several existing lodges and outpost camps, and provides high quality angling opportunities for walleye and trophy northern pike, as a result, the lake is a popular destination for fly-in tourist anglers.

Historically, a few lake and fishery surveys have been completed periodically since the early 1960's. Aquatic habitat inventories were conducted on Kesagami Lake in 1960 and 1965, however, little additional assessment occurred between 1965 and the mid 1980's. The first extensive sport fishery assessment was conducted in 1984 (Armstrong 1984) and found that walleye had a broad-based age distribution but length distribution was generally narrow, as a result of the slow growth rate. Similarly, northern pike were reported to have a wide age distribution. Anglers tended to harvest older walleye and northern pike age classes. Angler catch per unit effort (CUE) was relatively high for walleye (0.59) and northern pike (0.37) with 49.2% of walleye and 14.6% of northern pike caught being harvested by anglers.

Maturity and fecundity studies for walleye were conducted in 1984 (Payne 1985) and 1985 (Ladoucer and Payne 1986). The age of first maturity was 6 years for females and 5 years for males. Immature fish older than age 6 were reported for both sexes. The mean relative fecundity of 28,976 eggs/kg of body weight was considered low by Payne (1985) compared to other known populations, however, fall fecundity studies conducted on northern latitude lakes, may not show true fecundity values for spring spawning fish (B. A. Henderson pers. comm.).

The sport fishery was last assessed by Hendry and Payne (1987) using trap nets and creel surveys. Results showed that both walleye and northern pike harvest totalled only 17% of the estimated total potential yield (SPOF 12, OMNR 1982); that the Kesagami Lake Lodge may represent 85% of all anglers that use the resource; northern pike were older than was previously believed; and that the trophy northern pike population may be in danger of over-exploitation.

Management recommendations were made for this fishery as a result of these surveys. Brousseau and Armstrong (1987) suggested that slot limits, to protect the middle segment of walleye and northern pike populations and a limit of one trophy northern pike should be enacted. A daily catch and possession limit of two northern pike with only one greater than 71 cm in total length (TL) regulation was established (Hendry and Payne 1987).

Prior to 1994, little information was available concerning the current use and status of sport fish populations in Kesagami Lake. These populations are fished by tourist outfitter guests, by fly-in anglers and possibly some subsistence Native harvesters. Anecdotal evidence made by the current Kesagami Lake Lodge owner and the park superintendent suggests that the fishing quality and/or quantity have been reduced extensively over the past few years. Such speculation and lack of current fish use and population data resulted in a two year assessment program in 1994 with the following objectives:

1. To determine catch and harvest levels for the walleye and northern pike populations,
2. To determine the quality of the northern pike and walleye fisheries by estimating relative abundance, population characteristics, fish community structure and mercury contamination levels,
3. To document the spring walleye and northern pike spawning habitat and behaviour,
4. To propose fishery management strategies.

Thompson et al. (1996) reported the results of the 1994 study. This report presents the results of the 1995 field study and provides comparisons with previous years including 1994. This is the final report of the 1994 and 1995 fishery assessment program.

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STUDY AREA

Kesagami Lake is located within Kesagami Lake Provincial Park (Lat. N 50°23' and Long. W 80°15') approximately 137 km (85 miles) northeast of Cochrane, Ontario. The lake is situated in the Abitibi Upland of the Canadian Shield (Bostock 1970, Fig. 1). This physiographic area is composed of Precambrian bedrock and forms a gently rolling peneplain that dips gradually northward to the Hudson Bay Lowland. The area rises from the Lowland to a maximum elevation of 450 m and contains rocky landscapes, scattered lakes and glacial deposits (Thurston 1991). The elevation of the lake itself is 261 m, due to it's location at the northern part of the Abitibi Upland.

The lake is situated within the southern portion of the Hudson Bay Lowlands forest of the Boreal Forest Region (Rowe 1972). On poorly drained sites surrounding the lake, tamarack (*Larix laricina*) and black spruce (*Picea mariana*) dominate. Balsam poplar (*Populus balsamifera*), white birch (*Betula papyrifera*) and trembling aspen (*Populus tremuloides*) occur in upland areas.

Most of the lake shoreline is low (<6 m) with extensive areas of exposed stratified peat. The west shoreline contains boulders with rather steep banks (to 1.5 m). Sandy beaches are present along peninsulas, points and islands. Sub-surface boulders and shoals are present throughout the lake and can create a problem for aircraft access. Aquatic vegetation occurs primarily in shallow bays and protected areas.

The surface area of Kesagami Lake is approximately 17,120 hectares. The mean water depth is 2.3 m and the maximum depth is 8.0 metres. The lake does not thermally stratify. The morpho-edaphic index (MEI) ranges from 5.6 to 8.9, resulting in a mesotrophic classification (Adams and Olver 1977). Water colour ranges from yellow/brown to blue/green and buffering capacity is low (Lake Survey File 1984, Appendix 1).

Fish species reported for the lake include; walleye, northern pike, lake whitefish (*Coregonus clupeaformis*), lake herring or cisco (*Coregonus artedii*), white sucker (*Catostomus commersoni*), longnose sucker (*Catostomus catostomus*), shorthead redhorse (*Moxostoma macrolepidotum*), yellow perch (*Perca flavescens*), johnny darter (*Etheostoma nigrum*), slimy sculpin (*Cottus cognatus*), burbot (*Lota lota*), trout-perch (*Percopsis omiscomaycus*), ninespine stickleback (*Pungitius pungitius*) and spottail shiner (*Notropis hudsonius*) (Lake Survey File 1984).

A Native commercial fishery for walleye and northern pike occurred on the lake between 1958 to 1966, however, the fishery was uneconomical due to high transportation costs. Little commercial harvest was reported. Native subsistence fishing has also occurred in the past but little is known about this activity. In 1994 and 1995, no evidence of a Native subsistence fishery was evident.

Kesagami Lake is located in Fishery Division 25. There is no closed season for northern pike (except 24 Dec.), however, the walleye season is closed annually between 15 April and the third Saturday in May. Present catch and possession limits are two northern pike in one day or in possession, of which only one trophy fish may be greater than 71 cm (27.9 in) in total length. The standard walleye creel limit of six fish with no size limits is in effect. Recreational angling occurs between ice-out in May until early fall.

One tourist camp is located on the lake. Kesagami Lake Lodge was owned and operated by Natives from the mid 1950's to 1969 but was eventually sold to a private interest. The lodge was expanded in 1982 and was sold again in 1993 to the present owner. The new owners have established a voluntary fishing policy of catch and release of all walleye and northern pike but lodge anglers are known to harvest both species for shore lunches.

Access to the park and its resources is by aircraft or boat during the open water season. Winter access by snowmobile is prohibited by a regulation put in place in 1992.

METHODS

Creel Surveys

Two types of creel surveys were conducted on the lake to determine fishing effort, to estimate the number of fish caught, released and harvested and to estimate the catch per unit effort (CUE) and harvest per unit effort (HUE) for the major fish species caught. Fish attributes and angler behaviour and perceptions were also recorded (Thompson 1994). Data were compiled and analyzed using the CREESYS computer program (Lester and Trippel 1985) and are stored at the Cochrane Regional Office with a copy supplied to the OMNR Cochrane District office. Additional information was recorded in the field crew's daily journal.

Roving Creel

A roving creel survey was conducted between 29 May and 13 August, 1995. The survey design in 1995 was improved by adding a third spacial strata resulting in three creel areas (southwest, southeast and north, Fig. 2) compared to the 1994 study (Thompson et al. 1996). The change was made based on reports of fishing location from the 1994 study. Three time strata (0700 to 1230 hrs, 1231 to 1730 hrs and 1731 to 2230 hrs) were also used, for a total of nine strata. Stratification by day type (weekday vs. weekend) was not done because of the remote nature of the fishery. One space and one time period were sampled on a random basis, each day. We assumed that the activity within each time period had an equal probability of being chosen and that all anglers fished from boats. We grouped those that fished from airplanes into this fishing mode code. Check counts listed on the Creel Log Form were not completed for we assumed all anglers present were fishing. Data analysis did take into consideration guides that fished to give an estimate of total fishing pressure. Creel Log Forms and Creel Interview Forms were completed following methods described in the CREESYS user manual (Lester and Trippel 1985) (Appendix 2 and 3). Additional questions concerning angler behaviour and perceptions were asked the first time an angler was interviewed (Appendix 3). These questions were not coded into the computer analysis and were compiled by hand. Angling locations were recorded by dividing the lake into one km^2 blocks and using an alphanumeric grid to record locations (Fig. 2). Data were stored on 9 cm^2 computer discs and coded as PPN-CR-95-01.

Access Creel

An access creel survey was conducted at the Kesagami Lake Lodge's main dock between 29 May and 10 August, 1995. This survey was conducted within one time period (i.e. 1200 to 2400 hrs) and involved only one access point (i.e. total stratum count = 1). Creel Log Forms and Creel Interview Forms were completed following methods given in the CREESYS user manual (Lester and Trippel 1985). All trips were considered to be complete fishing trips. A few interview forms reported incomplete trips, since the anglers were considering fishing in the evenings. We modified these forms by recording the fishing trip as complete with the fishing stop time recorded as one half hour less than the interview start time. We felt that this new estimated fishing time was conservative. Activity counts were reported as the number of boats that landed at the dock. The first time anglers were interviewed at the access point, they were asked the same option questions asked during the roving creel, even if they had already been asked during the roving creel, since the two surveys were treated as independent studies.

The analysis of these data was similar to the roving survey. Data for the access creel were stored on computer discs and coded as PPN-CR-95-02.

Trap Netting Surveys

Two trap net surveys were also conducted in 1995. Spring trap netting was initiated to document walleye and possibly northern pike spawning and post-spawning concentrations. The summer survey was conducted to determine fish relative abundance, community structure and gather biological data for walleye and northern pike.

Both surveys were conducted using two, 1.83 m (6 ft) trap nets with 45.7 m (150 ft) leads. Leads were set on shore and the nets set perpendicular to the shoreline. Crews attempted to set nets where the minimum water depth was 1 m at mid-lead and 2 m at the gap. Nets were set overnight for approximately 24 hours.

Spring Spawning Survey

Nets were set throughout the lake at the same locations used in 1994 (Fig. 3). These sites were based on historic spawning information and the judgement of the netting crew. Net set number, gear characteristics, location, set and lift dates and times, substrate and cover, and weather were recorded on an Effort and Catch Form (Appendix 4). Species catch composition, sex ratios and spawning conditions were documented. Annotated notes were recorded in the daily diary. Fish biological attributes were measured as described below.

Nearshore Community Index Survey

This survey attempted to obtain an unbiased sample of the nearshore fish community. Where possible, methods followed provincial standards for nearshore community index netting (Willox and Lester 1994, Fulford 1993). Net sets were located at the same sites used in 1994 (Fig. 3). The lake and major island shorelines were divided into one km long sections and net set locations were picked randomly. Net set number, location, set and lift dates and times were recorded similar to the spring survey. More detailed information concerning gear description, effort, habitat and weather was recorded on standard Effort and Catch Forms (Appendix 4). The number of fish caught, by species, the occurrence of re-captures and biological attributes were also recorded.

Fish Biological Attributes

All fish encountered during the roving and access creel surveys and both trap netting surveys were sampled for biological attributes. Total length (TL), fork length (FL), round weight (RWT) and sex (spawning and sacrificed fish) were recorded and calcified structures were collected for age determination. Scales and dorsal spines were collected from walleye and yellow perch. Scales and pectoral fin rays were collected from northern pike, lake whitefish, lake herring and both species of suckers. Otoliths (walleye) and cleithra (northern pike) were collected from sacrificed fish. Biological data were recorded on scale envelopes in the field and later transferred to summary forms. Data sets for all surveys were kept separate. General observations concerning external parasites and general fish condition were also documented.

Ages were assigned to fish based on the ageing structure which had been given the highest confidence rating by the ager (M. Gauthier pers. comm.). When ageing structures had equal confidence ratings, the 'best' age was often indicated by the ager, or the most reliable ageing structure was used (ie. otolith preferred over fin rays or spines, which were preferred over scales).

Analysis of data consisted of determining overall and by age class the mean and 95% confidence intervals of measured attributes. Fork lengths were used for all analyses. Means were compared using ANOVA and t-tests. Length and age frequency distributions were constructed to describe fish population structure and were compared using the Kolmogorov-Smirnov (K-S) test (Sokal and Rohlf 1981). Growth of walleye and northern pike were described by fitting the vonBertalanffy equation to the observed mean size at age data. The equation was fitted using a Walford plot to estimate asymptotic length (L_∞) and growth coefficient, K (Ricker 1975); then a plot of L_∞-L_t by age to estimate T_0. These parameter estimates were then fine-tuned by fitting by eye to the observed data. Total mortality was estimated using catch curve, cumulative catch curve, Robson-Chapman method (Ricker 1975) and observed maximum age (Pauly 1984). Fish condition was described calculating the geometric mean regression of RWT on FL with $\log_{10}$

transformation and the Fulton condition factor. Fish condition between years was compared using analysis of co-variance. A p-value of 0.05 was used for all statistical tests. All statistical tests were completed using a SAS computer package.

Data from the 1984 and 1986 projects were reviewed and compared with 1994 - 1995 data when possible. Raw fish data were not available in a computerized format, therefore we relied on tables from the reports (Armstrong 1984 and Hendry and Payne 1987) and existing printed computer summaries.

Fish biological data from the 1994 and 1995 surveys were entered into computer spreadsheets for analysis and storage.

Water Sampling

Water temperature and dissolved oxygen profiles were recorded weekly at 12 water chemistry stations located throughout the lake. The same stations established during past lake surveys were used, with additional stations chosen in 1994 and 1995 (Fig.3). Water samples were used to record changes in the water column's temperature and dissolved oxygen statistics throughout the summer and to establish available habitat standards for both walleye and northern pike.

RESULTS

Creel Surveys

Catch and Effort

The roving creel survey was conducted between 29 May and 13 August, 1995. Two hundred and ninety-four interviews were conducted and 697 anglers contacted (Table 1). Estimated angler effort was 27,308 ± 5,288 angler-hrs (Table 1 and Fig. 4). An estimated total of 17,255 ± 7,179 walleye were caught, of which 4,318 ± 1,909 (25%) were harvested (Table 2, Fig. 5), resulting in a CUE of 0.63 and a HUE of 0.16 fish/angler-hr. An estimated total of 6,336 ± 1,907 northern pike were caught resulting in a CUE of 0.23 fish/angler-hr (Table 3, Fig. 5). No harvested northern pike were observed during the roving survey. Small numbers of lake whitefish and yellow perch were reported as incidental catch.

The access creel survey was conducted from 29 May to 10 August, 1995. Similar numbers of interviews (297) and angler contacts (692) occurred as for the roving creel survey. Estimated angler effort from the access creel survey was 16,999 ± 1,709 angler-hrs, which was more than 10,000 angler-hrs less than that estimated by the roving survey. The estimated catch of walleye was 13,580 ± 3,161 fish with 1,064 ± 223 (7.8%) being harvested. The estimated catch and harvest were 79% and 25% of the values estimated from the roving survey. The estimated CUE (0.80) was slightly higher and the HUE (0.06), much lower than estimated by the roving survey. The estimated catch of northern pike was 4,039 ± 515 for the access survey, 64% of the value estimated from the roving survey. A small number of harvested northern pike (6) were observed in the access creel, resulting in an estimated harvest of 25 ± 29 (0.6%) fish. The northern pike CUE from the access creel (0.24) was almost the same as for the roving survey.

Angling effort was also estimated by combining data from the creel surveys with post-season visitor statistics reported by Kesagami Lake Lodge (C. McDonald pers. comm., Appendix 5). Using this method,

angling effort was estimated to be 26,150 angler-hrs, which was similar to the result from the roving survey. Finally, a combined estimate of 19,125 angler-hrs was derived from the results of both creel surveys (Appendix 5).

The four estimates of total angler effort in 1995 range from 16,999 (access) to 27,308 angler-hr (roving). The pooled estimate using both survey results gave an estimate close to the access creel result (19,125 angler-hrs), while the estimate based on post season report by Kesagami Lake Lodge was similar to the roving creel result (26,150 angler-hrs). We feel that the 1995 access creel estimate is low because of the survey design and location of the field camp away from the Lodge, which made it more difficult to contact anglers compared to 1994. Review of the angling effort estimates for 1994 showed the reverse of what was calculated in 1995 (Table 4). The 1994 access creel produced the best estimate, however, we feel an improved 1995 roving creel design resulted in a much improved result compared to 1994 (Table 4). These improvements and the close agreement to the Kesagami Lake Lodge data indicate that the 1995 roving creel gave the best result. Therefore, the roving creel results were used to calculate the proportion of potential yield used by anglers in 1995.

A comparison of angler surveys conducted since 1984 is shown in Table 5. The only previous year for which an estimate of total angling effort was available was 1986 (1984 and 1985 surveys calculated observed effort, catch and CUE only). Angler effort has increased dramatically since that time, with corresponding increases in catch of walleye and northern pike. However, the harvest of walleye appears similar and that of northern pike considerably lower. Anglers have increased dramatically the proportion of fish that are live-released since 1986 with CUE's for walleye and northern pike remaining relatively unchanged.

Angler Demographics and Behaviour

Fishing Methods

Spin casting and combined methods were the most common angling methods used in 1995 (Table 6). Both creel surveys reported that these methods combined comprised over 65% of effort. Trolling and jigging were other commonly used methods, with similar results occurring for both surveys. These results were similar to those from 1994. Rankings were the same or differed by only one value. The greatest difference was that the 1994 roving survey reported a much lower proportion of anglers using a combination of methods (11.6%). The difference may be due to the way in which the creel crew, which was different in 1995, interpreted or asked this question.

Angler Origin, Accommodation and Experience

Anglers of U.S origin comprised 72% and 65% of anglers interviewed during the roving and access creel survey respectively (Table 7). Most of the remainder, 28% and 34%, respectively, were Ontario residents. Very few anglers came from parts of Canada outside of Ontario. The 1994 results were very similar with 69% and 68% of anglers originating from the United States, with most of the remainder coming from Ontario.

Most visitors to the lake were paid guests at a fishing lodge. Values for the roving and access creel were 84% and 94%, respectively (Table 8). The roving creel survey reported 12% of anglers as day trippers. The access creel sampled Kesagami Lake Lodge guests almost exclusively, therefore no day trippers were recorded. A small number of park campers and the lodge operators comprised the remainder of anglers

contacted. In 1994, both creels reported over 95% of anglers as being paid guests of a tourist camp, with the remainder being day trippers and non-permanent residents (ie. camp owners and staff).

Most anglers accessed the park using air service provided by Kesagami Lake Lodge (Table 9). The roving and access creel reported that 87% and 99%, respectively, used this method. The roving creel contacted 60 anglers (9%) who used Lindberg's Air service and 27 (4%) who used Konopelky Air Service. These were mostly the same anglers reported as day trippers, as the access creel reported only 2 anglers using those air carriers. Very small numbers of anglers were surveyed that visited the lake using private aircraft. In 1994, the roving and access creel reported 83% and 98% of anglers were accommodated at Kesagami Lodge.

Best estimates of the number of clients were provided by the outfitters as well. In 1995, Kesagami Lake Lodge had 577 guests (48%); Lindberg's Air Service: 270 (23%); Konopelky Air Service: 200 (17%) and others: 150 (13%). These numbers may suggest that Kesagami Lake Lodge did not have as high a proportion of anglers on the lake as found by the creel surveys; however, these numbers reflect the number of guests, not fishing effort. Many of the guests of other outfitters were not accommodated on Kesagami Lake, therefore they fished Kesagami Lake during a portion of their stay. In 1994, Kesagami Lake Lodge reported having 899 guests or 62% of all visitors. This was a larger number and greater proportion of visitors than 1995. Other outfitters reported similar number of guests in both years of the study (Table 9).

To try and estimate individual outfitter use, we assumed Kesagami Lake Lodge represented over 80% of the total angling effort with the remaining reporting outfitters contributing between 13 and 17% of the total use (Table 9).

Anglers fell into two groups with regard to the number of years that they had been visiting the lake (Table 10). The greatest number had only come once or twice (78% and 80% for roving and access creel, respectively). Most of the remainder, were long time visitors, having been coming for at least five years (16% and 14%, respectively). Similar results were found in 1994 when the roving and access creel reported 82% and 92% of anglers visiting for two years or less.

Shore Lunch Fish Consumption

Participation in the shore lunch consumption question was approximately 86% of all anglers creeled with the remaining anglers not participating or not questioned by the creel crew. The roving creel survey reported that 19% (115/599) of reporting anglers had a shore lunch on that day while the figure was higher (35% or 208/602) for the access creel (Table 11). The shore lunch consumption rate was calculated by dividing the reported number of walleye eaten by the total number harvested. Using observed harvest and shore lunch consumption data, the roving and access creels estimated that 38% and 76% of harvested fish were consumed during shore lunches. We believe that the estimate from the access creel is more accurate because anglers were contacted later in the day (ie. some roving creel anglers were contacted before lunch). Using the consumption rate of 76% and our best estimate of total harvest (4,318 fish, roving creel), the estimated total fish consumption at shore lunches was 3,273 fish (1,997 kg).

In 1994, shore lunch fish consumption rate was estimated at approximately 70% (roving) and 77% (access). These values are similar to the 1995 access creel value, supporting our belief that the 1995 access creel value is more accurate. Using the access creel consumption value and the 'best' harvest estimate of 2,640 walleye, total fish consumption was estimated at 2,028 fish (1,217 kg) or approximately 2/3 of the 1995 estimate (Table 11).

No northern pike were reported eaten during shore lunches in 1995 and only 8 estimated eaten in 1994. For the most part the northern pike fishery is used by tourists as a catch and release resource.

Areas of Fishing Pressure

Angler effort and catch were distributed fairly evenly between the three creel areas. Walleye catch, harvest and CUE were greatest in the southwest sector, while northern pike catch and CUE were greatest in the north sector. Fishing effort was concentrated around the shoreline, islands, shoals and bays (Fig. 6 and 7). Comparisons with 1994 (Thompson et al. 1996) showed that fishing pressure was most heavily concentrated in Kochichi, Little Ligigami and Ligigami bays in the north, along the western shoreline at H10 and I10, just inside Opimiskau Bay (G16), eastern shoreline of Big Island and the entrance of Newnham Bay (Fig. 6 and 7).

Angler Awareness and Opinions of Regulations

Anglers were generally aware of angling regulations on Kesagami Lake (Table 12). The roving creel reported 92% (302/348) were aware and the access creel, 100% (n=339). Similarly, almost all anglers were staying at a facility which had a camp policy regarding fish harvest (97% or 263/271 and 100% at n=292, respectively). In 1994, a lower percent of anglers reported being aware of the provincial fishing regulations (74% and 64%, for the roving and access creels respectively). The higher values from 1995 may be a result of better education by camp owners because of OMNR employees being present on the lake and/or the education by the creel crew during the study.

Total Potential Yield Estimates

Potential yields of walleye and northern pike were estimated based on SPOF 12 (OMNR 1982) and fishing quality management guidelines from northwestern Ontario (OMNR 1992)[1]. We compared our best estimates of harvest from the creel surveys and added hooking mortality factors to estimate total losses. Based on the literature, we used a hooking mortality of 5% for walleye. We used values of 5% and 10% to represent the possible range of hooking and handling mortality for northern pike, although the rate may be higher depending on age, sex, gear used and time of year (J. Casselman, pers. comm.).

Estimates of potential yield of walleye were 13,500 kg/yr and 9,400 kg/yr, respectively (Table 13). The estimated harvest of walleye in 1995 was 2,634 kg, based on the mean weight of angled fish of 0.61 kilograms. Adding a hooking mortality factor of 5% for released fish, the estimated total removal of walleye from the population was 3,029 kg, or 22% and 32% of the potential yield, for the SPOF and NW Ontario estimate, respectively.

Estimates of potential yield of northern pike were 10,600 kg/yr and 4,300 kg/yr, respectively (Table 13). The estimated harvest of northern pike in 1995 was 82 kg, based on the mean weight of sampled fish of 3.29 kg (very few angled fish were measured, therefore trap net fish were used to estimate mean weight as well). Adding hooking mortality factors of 5% and 10% for released fish, the estimated total removal of northern pike from the population ranged from 1,120 to 2,158 kg. This corresponds to 11% and 50% of the estimated potential yield, for the SPOF and NW Ontario estimate, respectively.

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[1] Fishing quality management guidelines established fish quality standards based on, allowable yield, CUE, fish size and effort (OMNR 1992).

In 1994, the estimate of walleye harvest was lower, therefore when the hooking and handling mortality factor was added total losses were only 2,252 kg, or 17% to 24% of potential yield. Northern pike harvest in both years was low, therefore the estimate of total removal was largely dependent on the estimated mean weight and the hooking mortality factor used. The mean weight of all sampled northern pike (trap net and angled) from 1995 was applied to the 1994 data as well, since we felt that the mean value of 5.5 kg was too high (Thompson et al. 1996). Applying these factors resulted in an estimated removal of 2,028 kg at 5% hooking mortality and 3,497 kg at 10% hooking mortality or between 19% to 81% of potential yield (Table 13).

Trap Net Surveys

Spring Spawning Survey

Twelve overnight trap net sets were completed between 28 May and 5 June, 1995 for a total of 222 trap net hours (Fig. 3). The same set locations used in 1994 were used in 1995. Water temperature during this period ranged from 9.5°C to 16.0°C and averaged 11.6°C (Appendix 6). Water depth at the gap ranged from 1.5 to 2 m and averaged 1.8 metres. Walleye (112 caught), northern pike (97 caught) and white sucker (126 caught) dominated the catch (Table 14). Lake whitefish (48) lake herring (12), longnose sucker (12) and yellow perch (2) comprised the remainder of the catch. Observations concerning catch composition were similar to that observed in the spring of 1994. Trap netting occurred after the peak of spawning for walleye and northern pike, and no observations of spawning condition or location were made in 1994 and 1995.

Nearshore Community Index Netting

Thirty-three overnight trap net sets were completed between 14 July and 8 August, 1995 for a total of 637 trap net hours (Fig. 3). The same set locations and numbering sequence used in 1994 was used in 1995, with the exception that nets were not set at sites 40 and 41. Air and water temperature averaged 19.9°C (range: 10° - 28°C) and 20.1°C (range = 17° - 24°C), respectively. Lake water level was low for much of the summer; as a result, water depth at the gap averaged only 1.2 m (range = 0.8 m - 2.0 m) and the netting crew had serious concerns regarding the capture efficiency of the gear. Walleye dominated the catch (Table 14, Fig. 8). A total of 177 were caught, resulting in a CUE of 5.4 ± 3.2 fish/overnight set. This was almost double the CUE recorded in 1994 (2.9 ± 1.1/set), but the difference was not significant because of the wide confidence limits. The northern pike CUE was similar in 1995 (3.4 ± 1.3/set) to the 1994 value (2.6 ± 1.1). The catch rates for both species of sucker and yellow perch were also, similar between years. The catches of lake whitefish and lake herring were significantly lower in 1995 than in 1994 (t-test, $p<0.05$). The confidence limits for all species catches were quite wide. The coefficient of variation ranged between 70% and 320% and averaged 152% of the mean catch/set for all species.

The 1984 trap net assessment occurred in the spring, and targeted areas of fish concentration; therefore, estimates of species composition and CUE may be biased and no comparisons were made with 1994 - 1995 data. In 1986, trap nets were set in late Spring (June 19 - 28) and mid-summer (July 16 - 23, Appendix 7). The summer CUE's were compared to 1994 - 1995, even though nets were not set randomly. The mean number of walleye caught, per over night set, in 1986 was much higher than in 1994 or 1995 (25.9 ± 20.0). The mean was inflated by two sets with catches of 103 and 83 walleye. Even if both sets were excluded from calculations, the mean was still higher than in this study (11.0 ± 3.46). The differences were not significant because of the wide confidence limits. The catches of most other

species were of a similar magnitude as in 1994 - 1995. Exceptions were relatively large numbers of yellow perch and white suckers caught in 1986. As with walleye, most of the yellow perch catch (140/147) occurred in three net sets.

Fish Attributes For Walleye

Length Distribution

The fork length distributions for angled and trap netted walleye are shown in Figure 9 and Appendix 8. In 1995, angled walleye ranged between 258 mm and 562 mm FL and 180 g to 1,600 g RWT (n = 245) (Appendix 11). Trap net caught walleye were represented by a slightly larger range of sizes (200 mm to 653 m and 70 g to 3,300 g, n = 266) (Appendix 10). Compared to 1984 and 1994, distributions in 1995 had the same mode (370 mm - 399 mm FL) but were less sharply peaked. The primary difference in the distributions was the presence of relatively more fish smaller than 280 mm FL in 1995 trap net samples. The 1995 trap net distribution was significantly different from all other years and gears (Kolmogorov-Smirnov test, $p<0.05$ Appendix 28). There were no other significant differences between the other distributions.

In 1995, the mean fork length and round weight of angled walleye were 386 mm ± 5.3 mm and 607 ± 24.3 g, respectively (Table 15). Trap net caught walleye were smaller on average (357 ± 8.1mm and 510 ± 39.6 g). The differences were significant (t-test, $p<0.05$).

In 1994, the overall mean fork length of angled walleye was 386 ± 7.6 mm, which was not different from the 1995 value ($p>0.05$). The mean for trap net caught fish was 388 ± 6.7 mm, which was different from 1995 ($p<0.05$). Comparisons were not made with 1984 and 1986 data as raw data was not available in a computerized format (multiple means should be tested using ANOVA). Also, reported standard errors for 1984 appeared to be incorrect. However, the average length of angled fish appears to have remained constant since 1984.

Age and Growth

The assessed age of 266 trap net caught walleye ranged from 2 to 32 years old (Figure 10 and Appendix 10). The modal age was 8, with other prominent year classes occurring at age 14 and 22. Age 2 and 5 walleye may also represent large year classes, but these ages were not fully recruited to the gear. The overall mean age was 11.9 ± 0.8 years. The angling fishery selected for significantly older fish (14.1 ± 0.7, t-test, $p<0.05$); the youngest fish caught was 6 years old and fish aged 8 to 16 dominated the catch. Overall, age 8, 12, 14, 20 and 22 fish appear to be from relatively large year classes, and age 11, 13 and 18 from small year classes. Large year classes that dominate the population are produced at irregular intervals of 2 to 6 years.

Combined trap net and angled data were compared among years (Fig. 11). Comparison with the 1994 age distribution shows the same large year classes, but one year younger; thus validating the ageing techniques used. The 1995 distribution shows a larger proportion of fish in the age 2 to 6 range, than in 1994. These may represent relatively large year classes that are just becoming vulnerable to the gear and can be expected to dominate the population in the future. Alternatively, the low water level experienced in 1995 may have resulted in increased vulnerability of younger walleye to the trap nets.

Reviewing historical data further showed that a few older aged fish were part of the 1984 and 1986 samples (Fig. 11 and Appendix 9). The 1984 and 1986 age distributions were skewed to younger age classes probably as a result of underestimating the older age classes. Comparisons made in 1994-95 between scale and dorsal spines showed that assessed ages from scales are less than for dorsal spines starting with age six with the difference increasing with age. The 1984 and 1986 age frequency distributions were based on scale age only, therefore comparisons of age distribution among years was not considered valid.

The growth of walleye in Kesagami Lake, was examined using the mean fork length at age (Fig. 11). Comparison of data from trap net and angling samples revealed no significant differences in mean length, by age (Appendix 10 and 11, t-test, $p>0.05$), therefore data from the two gears were grouped (Appendix 12). Comparison of male and female walleye showed that females were consistently larger for age 7 and older fish, with significant differences occurring only at age 14 (Appendix 13 and 14, t-tests, $p<0.05$). Differences were close to being significant at age 8, 12, 14 and 16 as well, where relatively large sample sizes were available. At other ages, sample sizes were small and confidence intervals too wide to detect any significant differences. Despite the differences, only 135 of 551 aged walleye were sexed, therefore all data were grouped for further analysis, to maximize the available information.

The selectivity of the trap nets and angling gear for larger fish resulted in poor sample sizes for fish less than 4 years old (Fig. 11). Therefore, the lower end of the growth curve is poorly defined and problems in fitting the vonBertalanffy equation were encountered. In general, fish growth was relatively rapid until age 8 - 10 and fork length of about 350 mm, with very little annual increase occurring beyond age 12. A decrease in growth rate, or the maximum size attained, appears to have occurred for fish in the 17 to 21 year old age classes.

The Walford plot of L_t on L_{t+1} was used to provide estimates of L_∞ and K. The L_∞ and K estimates did not fit the data well and were adjusted to fit, by eye. Because of poor definition of the growth for younger ages, T_0 was arbitrarily set at 0. The resulting vonBertalanffy equation was:

$$L_\infty = 414\ (1-e^{-.22(t)})$$

The average fork length of age 2 fish was 204 mm (n=2) and was only slightly smaller than the mean for age 4 fish (220 mm, n=9). The mean appears to be over-estimated and may be biased because of size selectivity by the trap nets for the largest fish in the age class. The larger than expected mean length for 2 year old fish may also be the result of large variation in growth between age classes. This anomaly made choosing the appropriate K and T_0 values for the vonBertalanffy equation quite subjective. Future assessments should attempt to capture more small fish, in an unbiased fashion, to better define this part of the growth curve (eg. seine netting at night).

The 1995 value of L_∞ (414 mm) was slightly higher and that of K (0.22), lower than those fit to the 1994 data (395 mm and 0.30, respectively). This resulted in the curve that increased more gradually to a slightly larger ultimate size. This slow growth rate seems typical of more northern Ontario lakes (Scholten 1992). Comparison of mean length at age for trap net caught fish showed no differences up to age 7; in 1995, age 8 fish were larger and age 9 smaller (t-test, $p<0.05$). Comparisons were not made beyond age 12 as fish older than 12 approached their asymptotic size, with little annual growth and large variation in size at age occurring.

Age distributions and resulting growth curves from studies conducted in 1984 and 1986 were based primarily on ages from scales which under-estimate true age. As a result, the distributions were truncated and growth appears to increase throughout life. Armstrong (1984) made estimates of the vonBertalanffy parameters of: L_{∞}=463; K=0.16; T_0=-1.37. These values now appear to be valid.

Biased age data can be adjusted using an age-age key; although conditions for their use apply. A key was constructed for the 1995 walleye data (Appendix 23 and 24). It shows that the assessed scale age under-estimates the assessed dorsal spine age (assumed to approximate the true age) for fish as young as age 6. The age of almost all fish older than age 10 are under-estimated using scales; with the effect increasing with age. Re-calculation of previous data using an age-age key were not completed during this analysis.

Mortality

The standard and cumulative catch curves, using ages 9 to 27, gave mortality estimates of 7% and 20%, respectively; the highest and lowest values of the four methods used (Table 16). The Robson-Chapman and maximum age methods yielded similar values of 12% and 13%, respectively.

The use of catch curves to estimate mortality requires an estimate of the age at which full recruitment occurs, usually taken as the modal age plus one (age 9 in 1995). However, recruitment in the Kesagami Lake population is highly variable from year to year making it difficult to determine the age of full recruitment and violating a condition of using catch curves (ie. constant recruitment). Also, we were uncertain if several of the other conditions required to use the catch curve method were being met and the potential effect on mortality estimates. Therefore we conducted a sensitivity analysis comparing instantaneous mortality rates (Z values) obtained using a variety of age ranges. Figure 12 shows values of Z obtained using different years of first recruitment, plotted at that year. For both methods the points form a logarithmic curve, with Z increasing as minimum age used in the calculation increased. Between the ages of 9 (the age used in this analysis) and 15, Z varied from 0.08 to 0.11 (A = 7% to 10%) for the standard catch curve, and 0.23 to 0.32 (A = 20% to 27%) using the cumulative catch curve. This analysis indicated showed that our choice of age 9 as the age of full recruitment, gives a similar estimate of Z as other ages up to 15, hence the selection of age 9 seems appropriate.

In 1994, the standard and cumulative catch curves gave estimates of 5% and 19%, respectively, using ages 8 - 29. The Robson-Chapman method (10%) and maximum age (14%), as well as the catch curves all yielded results similar to those observed in 1995 (Table 16).

Condition

The relationship between fork length and round weight of walleye from all gear types in 1995 was:

$$\log(RWT) = 3.031\log(FL)-5.075$$

Anti-logged, the relationship becomes:

$$yRWT = 8.413*10^{-6}(FL)^{3.031}$$

The Fulton condition factor of individual fish ranged from 7.75 to 13.88, and did not vary significantly with fish size ($p>0.05$, r^2=-0.001, Appendix 27). The average of 511 fish was 10.17 ± 0.07. For a given length, walleye were considered to be relatively heavy and in excellent condition.

Analysis of co-variance (ANCOVA) was used to compare condition between years, taking into account the differences in the sizes of fish sampled (Appendix 27). Using log-transformed data, there was a significant difference in log RWT between 1994 and 1995, after accounting for differences in length and the interaction ($p<0.05$). Though significant, when the data points and regression lines for both years were plotted together, the difference appeared very small. In 1994, the regression intercept was larger but the slope lower, resulting in a line that crossed the 1995 line in the middle of the observed data range.

Fish Attributes For Northern Pike

Length Distribution

Fork length distributions for trap netted northern pike are shown in Figure 13 and Appendix 15. Angled northern pike were omitted from the analysis because of the small sample sizes available in most years. Northern pike ranged between 260 mm and 1,075 mm FL and 120 g to 11,000 g RWT (n = 185, Appendix 17). The means were 700 ± 27.1mm and 3,283 ± 376 g, respectively. The distribution did not have a distinct mode; with similar numbers of fish occurring in all size classes between 450 and 999 millimetres. Fifty-six percent of sampled fish were greater than the 710 mm TL (670 mm FL) one-over-max. size limit. Guides from Kesagami Lake Lodge provided total length measurements of 138 angled northern pike in 1995 as well. The lengths were converted to fork lengths using the regression equation calculated from the 1995 survey crew fish sampling program. Rounding of lengths by the guides resulted in a somewhat abnormal distribution (ie. adjacent high and low class frequencies). The distribution would probably be smoother with more precise length measurement. Regardless, the length range of fish sampled and the overall distribution appears visually similar to that for survey crew measured fish, however, the distribution of guide measured northern pike was significantly different from the 1994 and 1995 trap net distributions (Kolmogorov-Smirnov test, $p<0.05$ Appendix 29). The mean fork length of guide measured fish was 587 ± 31.8mm, which was significantly smaller than trap net caught northern pike (t-test, $p<0.05$). Forty-one percent of guide measured fish were longer than the size limit.

Comparison with the 1994 trap net distribution suggests that a greater proportion of smaller fish were caught by trap net in 1995. The Kolmogorov-Smirnov test found that the distributions were not significantly different ($p>0.05$), but the mean fork length of 759 ± 29.5 mm was significantly larger than the mean in 1995 (t-test, $p<0.05$).

Statistical tests comparing 1984 data to recent data could not be done as raw frequencies were not available. In 1984, fish in the 700 mm to 849 mm length classes dominated the catch and 47% of fish were longer than the minimum size limit. The mean length of trap net caught northern pike in 1984 was 684 mm (Table 15). The reported standard error of the mean (170 mm), appears incorrect compared to 1994 and 1995 data, therefore comparisons were not made (1984 raw data was not available for re-calculation).

Overall, the proportion of fish longer than the size limit was higher in 1994 and lower in 1995 than was observed in 1984. Therefore no conclusion can be made regarding the potential influence of the maximum size regulation on the population structure. However, the abundance of older age classes (see next section) remaining within the population despite angler pressure increase of about 130% shows that the catch and release policy and the maximum size limit regulation may have helped sustain a trophy northern pike population since 1984.

Age and Growth

The assessed age of 185 trap net caught northern pike ranged from 2 to 19 years old (Figure 14 and Appendix 16). Fish aged 5 to 8 dominated the catch. The overall average age was 8.7 ± 0.6 years. In 1994, the age 5 to 8 year classes were much less dominant. There is no clear correlation in large year classes between years, with the possible exception of age 1 fish in 1994 which appeared as a strong year class as 2 year old fish in 1995. Northern pike distributions showed a rather block frequency distribution in 1984 and 1986 with a more uneven distribution in 1994 and 1995. Strong age classes during the mid life years are required to ensure that very old, trophy fish are present in future years (J. Casselman pers. comm.).

Sex was determined for very few northern pike, therefore all trap net data were lumped for further analysis. The mean length and confidence intervals, by age are plotted in Figure 14. Growth in length is more gradual but continues at a higher rate throughout life than it did for walleye. The Walford plot provided estimates of L_∞ and K that fit the observed data well, as did the plot of $\ln(L_\infty - L_t)$ which produced an estimate of T_o. The resulting vonBertanlanffy equation was:

$$L_t = 1113\ (1-e^{-.11(t+1.13)})$$

The line fitted to the 1994 data used a slightly lower value for L_∞ (1000 mm) and higher value for K (0.16) resulting in a line that increased at a greater rate initially, but reached a slightly lower asymptote. Northern pike showed better than expected growth for such a northern population (K between 0.11 and 0.16). We expected that northern pike generally have a decreased growth rate but live longer than those populations found further south (Scott and Crossman 1973). Kesagami Lake northern pike show relatively good growth rates and longevity.

There were no significant differences in mean fork length at age between 1994 and 1995. The mean fork length at age 10 and 12 was smaller in 1986 than in 1995 (t-test, $p<0.05$). Confidence limits in 1984 were very wide and no differences from other years were detected.

Condition

The relationship between fork length and round weight of northern pike from all gear types was:

$$\log(RWT) = 3.312\log(FL) - 6.017$$

Anti-logged, the relationship becomes:

$$RWT = 0.961 * 10^{-6}(FL)^{3.312}$$

The Fulton condition factor of individual fish ranged from 4.74 to 10.16, and varied significantly with fish length ($p<0.05$, $r^2=0.07$, Appendix 27). The average of 191 fish was 7.41 ± 0.15. Fish were divided into three length classes, since the condition factor varied positively with fish size. However, there was no relationship between length and condition. The mean condition factors for fish <600 mm FL (6.51 ± 0.15), 600 mm - 799 mm FL (7.47 ± 0.20) and >799 mm FL (8.20 ± 0.25) were significantly different from each other.

There was a significant difference between 1994 and 1995 log-transformed regression of RWT on FL after accounting for differences in length and the interaction (ANCOVA, $p<0.05$ Appendix 28). The 1994 regression line was above the 1995 line for most of the observed data range; crossing at the upper end.

Fish Attributes for Other Species

Biological attributes of all species captured in trap nets were recorded in 1995. The length distributions, age distributions and length-at-age are shown in Figures 15 and 16 and Appendix 18 - 22. Sample sizes were small, with all species having less than 30 samples, except for white sucker which had 46. Kesagami Lake produced some very old longnose and common white suckers with both species containing large individuals 17 years and older. Great discrepancy was shown between scale and pectoral fin ray ages (i.e. scale age was listed at 10 years of age with pectoral fin ray showing 20 years of age). Such discrepancy concerning sucker age structures have been noted in the literature (Scott and Crossman 1973). Twenty-nine lake whitefish were captured; ranging in fork length from 292 mm to 457 mm and 4 to 20 years of age. As with walleye, lake whitefish in Kesagami Lake appear to be long lived but grow relatively quickly to a small maximum size, with little growth in length occurring after age eight. Kesagami Lake whitefish growth rates approach those reported for Great Slave Lake (Scott and Crossman 1973), so they may react more like arctic populations than those stocks found further south. Lake herring ranged in length from 142 to 312 mm FL and 1 to 9 years of age. Yellow perch are near the northern limit of their natural range in Kesagami Lake. As with all of the other species, a wide range of sizes and ages are represented in the population.

Water Chemistry

Weekly water temperature and dissolved oxygen profiles were measured at each of 12 measuring stations. Original field data sheets are stored in the Kesagami Lake survey file. During the period of temperature recording (June 25 - Aug. 13), surface water temperature fluctuated between 15.1 and 23.0°C and averaged 19.3°C (Figure 17 and Appendix 30).

DISCUSSION

Creel Surveys

Catch and Effort

Angling effort on Kesagami Lake has increased dramatically since the last assessment was conducted in 1986. Hendry and Payne (1987) estimated effort to be 12, 911 angler-hrs or 0.75 angler-hrs/ha between 18 May to 21 September, 1986 compared to our 1994 and 1995 estimates of 30,500 angler-hrs (1.8 angler-hrs/ha) and 27,308 angler-hrs (1.6 angler-hrs/ha), respectively. Our 1994 pooled estimate was supported by the result of the improved 1995 survey design; therefore we feel that these values accurately reflect angling effort during the creel period. Additional angling effort occurred before and after the creel period but we feel the effort was minimal.

In 1984, the majority of anglers were from Kesagami Lake Lodge which was running at 15% of total capacity. Hendry and Payne (1987) predicted that angler use would drastically increase in the near future with increased use of the lodge. Increased outfitter use and promotion of the fishery resource has resulted in more than doubling of the angling pressure on Kesagami Lake in less than 10 years.

Previous to the 1994 and 1995 assessments anecdotal evidence suggested that the walleye and northern pike may be experiencing over-exploitation or what past fishery managers (OMNR 1983; Baccante and Colby 1991) refer to as "societal overfishing"[2]. Angling quality (average fish size) and angling quantity (CUE) decline as angling effort and total catch increase. As effort increased on Kesagami Lake, there has been a corresponding increase in total catch of walleye and northern pike but harvest per angler (HUE's) have consistently dropped since 1984 without any apparent drop in CUE's (Armstrong 1984 and Hendry and Payne 1987).

There has not been a corresponding increase in fish harvest because the rate of catch and release has increased dramatically. During this two year study, harvest estimates ranged from a maximum of 23% to 25% of estimated walleye caught and 0.4% to 2% of estimated northern pike caught. Kesagami Lake Lodge, the largest outfitter using the lake, has implemented a camp fishing policy of a daily fish shore lunch, a take home limit of two walleye and no-kill policy for northern pike. Ownership of Kesagami Lake Lodge changed in 1993 and it is now operated at near-maximum capacity (70 beds) during the late-May to mid-August period. Angling pressure from clients of outpost camps adjacent to the park and independent fly-in park users has also increased (Ed Larose pers. comm.). If fishing efforts remain relatively the same, if the Kesagami Lake Lodge fishing policy remains in effect and given the continued dominance of Kesagami Lake Lodge clients as users of the fishery, we expect no dramatic increases in HUE of walleye and northern pike. However, if total angling effort increases through new allocations or increased accommodations (e.g. increase use of Edgar Lake camp following purchase by Kesagami Lake Lodge) in or adjacent to the park, total catch and harvest can be expected to increase. Such increases may not be sustainable in terms of maintaining current CUE and HUE levels. Procedures to determine allocations, monitoring and compliance must be resolved using a multi-management or ecosystem management strategy.

The relative rate of exploitation of the fishery was examined using quality standards based on CUE's (OMNR 1992 and Colby et al 1979). The use of CUE as an index of the quality of the fishery and fish abundance should be exercised with caution. In the three consecutive years between 1984 - 1986, walleye CUE varied between 0.6 and 1.0 and northern pike CUE ranged from 0.2 to 0.4. Similarly, between 1994 and 1995 walleye and northern pike CUE's were quite different. This large variation, during consecutive years, when conditions in the fishery were constant, emphasizes the fact that very large changes in fish abundance may occur before a distinct trend in CUE becomes obvious. We recommend that angling CUE be used as an indicator of fishing quality, but should be interpreted with caution when used as an index of fish abundance. Observed and expected angler CUE's for 1994 and 1995 were well within or exceeded the 0.30 and 0.80 levels established for a good quality walleye fishery (0.40 and 0.84; Thompson et al. 1996 and this study). Similarly northern pike observed and estimated angler CUE's generally exceeded the quality standards of 0.1 to 0.30 (0.18 and 0.35; Thompson et al 1996 and this study) and were generally larger than the 0.13 value expected for a trophy fishery (OMNR 1992). We feel that both populations should be managed as quality fisheries, however, the preservation of the large "trophy" northern pike must be addressed in any future resource management decisions.

Measurement of fishing quality and the fishing experience can involve a variety of statistics that blend both fishery science statistics with other human requirements and perceptions (Steedman and Haider 1993). When anglers experience reduced catches and sizes of fish, the quality of the fishery is considered

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[2] Societal overfishing occurs when a system is open to exploitation and over time reaches a point where anglers begin to complain about the size and number of fish caught compared to earlier fishing experiences.

reduced. An index of fishing quality was proposed by Colby (1984) to calculate a walleye Quality Fishing Index (QFI). We calculated this for 1994 to be 52.7% (Thompson et al. 1996) based on trap net data, for few walleye were measured in the standard creels due to the large proportion of live released fish. In 1995, we concentrated on creel caught fish and determined a walleye fishing quality index of 52.4 based on the following;

QFI = 0.77 x 0.68 *Where Proportional Stock Density (PSD) = 0.77 and mean observed CUE from the roving and access creel surveys = 0.68.*

Baccante and Colby (1991) reported that 77% of the lakes in their data set had QFI's of less than 20 per cent.

The PSD value illustrated that the mean size of angled walleye was small and could result in some users perceiving that the angling quality had deteriorated, however, the walleye population showed relatively high abundance based on a high angling CUE value. Small average size and restricted size distribution that have been reported by Armstrong (1984), Hendry and Payne (1987), Thompson et al. (1996) and this study we feel are a result of slow growth rates generally exhibited by walleye stocks positioned further north. Increased exploitation of walleye could decrease abundance but could result in increased growth rates. However, genetics and environment may play key roles as well. Sporadic fluctuations in age classes previously mentioned could also effect recruitment negatively and the ability of the fishery to sustain heavy fishing mortality (Baccante and Colby 1991).

Angling catches and perceptions of angling quality may also be influenced by fish behaviour. Reported reduced catches may have resulted in normal walleye movements throughout the season. Kesagami Lake's shallowness may result in walleye migrating to deeper portions of the lake as the summer advances or become less active resulting in fewer walleye being caught by anglers. Such angler perceptions must be examined within the context of the available data concerning the complexity of the aquatic ecosystem.

Catch and Release Mortality

Hooking mortality of walleye has been well studied and generally appears to be low (less than 5%) under minimal handling and immediate release conditions (M. Powell, pers. comm.). Walleye hooking mortality may increase if release is delayed, fish are taken from depths of greater than 9 m or taken during live release tournaments. We do not expect walleye to experience heavy hooking mortality if fish are played and landed quickly, with as little handling as possible.

Little information exists regarding the hooking mortality rate of northern pike. Estimates of 10% to 20% may not be unreasonable with as much as 30% or more for small or trophy sized individuals (J. Casselman pers. comm.). Hooking mortality is influenced by angler skill, season, sex of fish and gear. Anglers handle the medium sized fish (50 cm to 80 cm TL) better than the smaller fish and those northern pike greater than 80 cm in total length. The larger fish may be susceptible to mortality rates of 30% or more for anglers have a difficult time in handling these large fish and for the smaller fish anglers tend to over handle them, hence increasing handling or hooking mortalities.

The general physiology of the fish, the time of year and natural history of the fish are very important in determining the susceptibility of northern pike to hooking and handling mortality. Northern pike are more susceptible to hooking mortalities in the summer when water temperature reaches 23°C stressing the fish.

Optimum temperature for northern pike is about 20°C (J. Casselman pers. comm.). We recorded water temperatures throughout the 1995 field season during trap net sets and weekly water chemistry assessment monitoring. Trap net water temperatures at 0.3 m from the surface showed that temperatures reached 23°C during the last week in July (i.e. 23 July to 28 July). Chemistry stations scattered throughout the basin, within deeper waters, generally stayed at the optimum temperature of 20°C for northern pike. The exception was a shallow chemistry station (Station #11 located in Little Ligigami Bay) which recorded a temperature of 23°C during the second week in August. Additional protection could be secured for summer caught northern pike if angling is restricted within nearshore and shallow bay areas when temperatures reach 23° Celsius.

Male northern pike are more susceptible to hooking mortality in the summer than females but this susceptibility is reversed during the fall season. Generally, hooking mortality for both sexes increases during the fall when fish are not feeding as actively and if stressed by angling, over winter death is increased. In addition, mature females start to develop eggs in the fall which requires considerable energy reserves. Additional stress on females can lead to decreased survival (J. Casselman pers. comm.).

Northern pike are omnivorous carnivores and tend to ambush their prey with short swimming bursts. Their physiology supports this feeding behaviour but is not suited to excessive landing times caused by being caught on light tackle or played excessively by an angler. Heavier gear and more direct landing and removal of hook without excessive handling could also reduce hooking mortalities. The use of single barbless hooks and encouraging anglers to raise only the fishes head out of the water and quickly releasing it would also reduce hooking mortalities (J. Casselman pers. comm.). Annual extensive education of anglers may be warranted and assessment of the hooking mortality rate of summer caught northern pike in Kesagami Lake should be investigated.

Total Potential Yield and Resource Allocation

Estimated total losses of walleye and northern pike are currently well below present total potential yield estimates. In 1995, total losses (harvest plus hooking mortality) of walleye and northern pike ranged between 22% and 32%; and 11% and 50%, respectively, of the total potential yield, depending on the estimator and level of hooking mortality used. Present models to predict total potential yields (TPY) as they pertain to Kesagami Lake walleye and northern pike are discussed in Thompson et al. (1996). Estimates of total potential yield vary widely and are based on empirical models that describe average conditions across a set of lakes; therefore they do not necessarily describe conditions in any specific lake. For this reason, comparison of observed harvest to estimates of potential yield should be done with caution. When available, trend-through-time data on indices of fish abundance, fish biological attributes and behaviours are preferred to assess the status or trends in the fishery.

The current regulations and live release policy have kept harvests low, while effort and catch have increased. However the dramatic increased incidence of catch and release fishing has highlighted the issue of hooking and associated handling mortality. We feel that walleye total losses are not excessive with additional kilograms of fish available to anglers for catch and or harvest. However, total losses of northern pike may be approaching a critical level (81% based on 1994 estimates) - especially if the large fish component of the population is to be maintained.

Decisions regarding future allocations must take into consideration many issues. These could include; the limited knowledge we have concerning total potential yields for walleye and northern pike; lack of good

northern pike hooking and handling mortality rates for all age and size classes; lack of information concerning losses as a result of fishing that include hooking mortality as well as harvest; the absence of desired fish quality standards; the need to monitor angler effort and harvests by tourist outfitters; need to monitor the presence of Native subsistence users and anglers independent of outfitters with reduced funding and the lack of direction to manage all the resources within the park on a sustainable level.

Kesagami Lake is located within a wilderness class provincial park; therefore we believe that the fishery should be managed to maintain fish populations that exhibit characteristics of relatively low rates of exploitation. These conditions currently exist; therefore we feel that the effort and fishing quality criteria that reflect the current state of the fishery be set as standards for the purpose of management planning.

Angler effort on the lake should not exceed our upper estimate of 30,500 angler-hrs, during the current summer season (ice-out to August 15). If there is a significant increase in angling effort outside of this time period, it should be addressed In terms of our 1995 estimate this represents a modest increase of 3,192 angler-hrs. Expressed in terms of the number of anglers, a maximum of 1,500 anglers per year would be allowed or an increase of about 300 anglers from the 1995 estimates. Setting the standard as the number of anglers is more practical for allocation purposes.

The 1,500 anglers per year recommendation is based on our estimates of total losses for northern pike. This should result in an estimated 2,265 (at 5% hooking mortality) and 3,905 kg (at 10% hooking mortality) of northern pike harvested or lost due to hooking mortalities annually. Such use may result in a loss of 90% of the total potential yield for northern pike. Losses of walleye can be expected to increase accordingly, as most anglers target both species. However, such increases should continue to maintain the high quality walleye fishery. Increases to allocations could occur if ongoing assessment indicates that fish population standards are not being adversely affected or revised potential yield estimates become available. To achieve this objective continued assessment must be funded. Assessment could follow this study but could also involve a lower level of monitoring annually and research concerning northern pike hooking and handling mortality. Cooperative programs with tourist outfitters and universities should be considered.

To achieve the objective of 1,500 anglers annually, we believe the present amount of accommodation available in and adjacent to the park should not be increased. If an additional modest increase is established, the allocation should go to independent park visitors. Tourist outfitters and OMNR district and parks staff must be aware that if Native fishery resource requirements are requested then present allocations to other users will have to be reduced. The monitoring of both tourist outfitters and the general public should continue to be maintained by the Cochrane District office and placed within the fishery database.

Future allocations should be established within a holistic or ecosystem management framework based on the known biology of the species in question and on the present use that is made of the resource within and with access to Kesagami Lake. Managers must realize that not all resource allocation requests can be satisfactorily mitigated and limitations of our regulations must be understood.

Finally, we propose that tourist outfitters be made aware of our concerns regarding the following:

* present northern pike exploitation levels that include hooking and handling mortalities be noted;
* that suitable gear be used to land northern pike in an expedient manner;
* that catch and release educational material for walleye and northern pike be made available;

* that voluntary angling restrictions be in effect within nearshore and shallow water bays during the mid-summer months, if surface water temperatures reach 23^0 C;
* that protection and periodic low cost monitoring (i.e. efforts, harvests and CUE's) of the fishery be required;
* that the number of anglers that use the resource be requested from tourist outfitters annually;
* that whitefish be considered as a possible unexploited resource (see community structure);
* that development within and around the park respect established allocations to maintain this high quality fishery;
* that managers are required to allocate to the resource first, then First Nations, if requested, and then to the remaining clients, if such allocations can bc sustained;
* that a fishery strategy is required and should be established in the near future with all interested clients. If a strategy is not forthcoming, OMNR will act to protect this northern pike trophy fishery.

T.ap Net Surveys - Community Structure and Abundance

Spring trap net surveys have been conducted throughout the history of population assessment at Kesagami Lake. During the 1984 - 1986 period, net set sites were chosen specifically in areas where large numbers of fish were expected to be caught. This method supplied large numbers of fish for biological sampling with limited effort, but did not produce a useable index of fish abundance. The nearshore community index (summer trap netting) conducted in 1994 and 1995 was designed to obtain an unbiased index of the large fish community. Techniques and gear used followed provincial standards aimed at producing data comparable between lakes and years. Unfortunately, the recommended gear was considered less than optimal for the shallow water conditions experienced in Kesagami Lake. The gear used in both years were 6-foot trap nets with 150 ft leads. In many areas, water 2 m deep did not occur, especially in 1995 when the lake water level was lower than normal. The netting crews, in both years, expressed concerns over the fishing efficiency of the nets when they were partly collapsed. Smaller trap nets or other modifications to the recommended methods should be considered in future assessments.

Despite the limitations, the summer trap net survey provided a good picture of the fish community. Relative abundance of all species except the two coregonids, was similar between years. Walleye, northern pike, lake whitefish and white sucker dominate the community. Lake herring is the most common medium sized species. Both walleye and northern pike are the two dominant, shallow water predators within Kesagami Lake. Walleye are known to feed on a great variety of fish species including; lake whitefish, lake herring, longnose and white sucker and the complement of bait fish present within Kesagami Lake (Scott and Crossman 1979). The small average size of walleye suggests that smaller species, not vulnerable to trap nets, may be their primary food source. Lake herring, walleye and to a much lesser extent yellow perch are probably the major forage species for northern pike. Northern pike is probably the major predator and shallow water competitor of walleye.

Past surveys have shown that summer nearshore, net sets were dominated by lake whitefish (Hendry and Payne 1987 and Thompson et al. 1996). It appears that low water levels in 1995, restricted the use of shallow nearshore waters by lake whitefish and lake herring. Like angling CUE, trap net CUE is subject to large intra-year confidence limits and inter-year variation. Trend-through-time analysis of a variety of indices, including trap net CUE should be used to monitor the Kesagami Lake fishery.

In years of normal water levels, lake whitefish is the dominant littoral zone species in the spring and early summer months but it is not exploited by anglers. By modifying techniques (i.e. use of fly-fishing methods), this species would be available to anglers.

Finally, northern pike may have experienced greater temperature stress within the shallower near shore areas in 1995 compared to 1994. Generally a fish of heavy vegetated areas and warm bays they are relatively sedentary and establish weak territories but will move in summer to cooler portions of the lake (Scott and Crossman 1969). We found that northern pike incidence within open, nearshore communities decreased between spring and summer, so generally northern pike may have moved to cooler waters as the summer progressed. For those northern pike that remained or visited the nearshore areas during the summer of 1994 and 1995, reduced water levels in 1995 seem to have little effect on the numbers of northern pike caught in summer net sets.

Fish Attributes for Walleye

Walleye showed expected growth rates as reported by Armstrong (1984), Payne (1995) and Hendry and Payne (1987). However, improved aging techniques revealed a much wider and irregular age distribution that was reported in previous assessments. Normally, a change in length distribution would be expected if the age composition or the growth rate of the population changed. A change in this attribute can be useful to determine the changes in the fishery. However, given the wide range of fish ages represented by any length class of fish, the length distribution may not change greatly. The position of the descending limb of the length distribution would not be expected to change unless a change in growth rate occurred. The shape and position of the ascending limb is dictated by the selection curve of the gear and year class strength of the cohorts that are being recruited to the gear. We observed no differences in walleye length distribution between years, except for trap net caught fish in 1995. The 1995 trap net results indicate the presence of fish in the 180 to 249 mm length classes, which are mostly 2 and 4 year-old fish. The occurrence of 4 year-olds in 1995, but no 3 year-olds in 1994, suggests that small fish may have been more vulnerable to the gear in 1995, possibly because of the low water level or young fish of a large year class being recruited to the fishery.

The modal length class of 370 mm - 399 mm recorded in 1994 and 1995 for angled and trap net walleye corresponds closely with the modal length of Missisa, Pledger and Muswabik Lakes (375 mm - 400 mm, Scholten 1992). These lakes are large, shallow, northern lakes, similar to Kesagami, within the Hudson Bay Lowland and experience low levels of exploitation.

Comparisons of age composition and growth from previous assessments can not be done because of the inaccurate aging. However, the current age structure includes large numbers of older, mature fish, occurring in irregularly spaced, large year classes. The range of ages and large variation in year class strength observed were similar to that of Missisa, Pledger and Muswabik lakes, with the exception that the variation appears even more exaggerated in the Hudson Bay Lowland populations (Scholten 1992). In harsh environments, for a species whose reproductive success is controlled by environmental conditions, a relatively large, multi-aged spawning stock is required. This ensures that there will be adequate egg production during years when environmental conditions are favourable for the production of large year classes which support the fishery.

The L_∞ and K values estimated for Kesagami Lake walleye (414 and 0.22) are similar to those for Missisa (430 and 0.20), Pledger (410 and 0.25) and Muswabik (430 and 0.23) lakes (Scholten 1992). This slow growth rate seems typical of shallow northern Ontario populations. Kesagami Lake walleye tended to approach asymptotic size relatively early in life (12 plus-year-olds). This characteristic has implications concerning human health issues. Consumption restrictions due to mercury contamination are based on fish length. However, actual contaminant levels are often more dependent on fish age; therefore, for slow growing species, a given length class may contain fish of a wider range of ages and a wide range of contaminant levels. The implications of this phenomenon on consumption guidelines should be reviewed when data becomes available.

Mortality rates for walleye populations in Missisa and Pledger lakes were calculated using the two catch curve methods. The values of Z for Missisa Lake were 0.07 and 0.21 for the regular and cumulative catch curves, respectively, and 0.18 and 0.38 for Pledger Lake. The values for Missisa Lake, which has virtually no exploitation, were very similar to values reported by this study (0.8 and 0.23). Pledger Lake, which has some Native harvest, had slightly higher mortality rate estimates. The size, age, growth and mortality rates show that the walleye population of Kesagami Lake shows characteristics of Hudson Bay Lowland lakes with low levels of exploitation.

Various methods of estimating mortality have a variety of conditions and assumptions for their use, many of which were not met with the Kesagami Lake data (Ricker 1975). The maximum age method is based on an empirical relationship, and therefore is free from many of these assumptions, and may therefore be least biased. However, the method is sensitive to the sample size examined. An alternative method incorporating sample size was developed by Hoening and Lawing (1982) and presented by Pauly (1984), however, it was recommended that the method is best suited for fast growing, short lived species. Also, the method requires an estimate of the mean age of first capture, which wasn't readily available from the data.

The catch curves and Robson-Chapman methods assume that mortality rate remains constant over time. Because of the long-lived nature of the species a change in total mortality may not be detected immediately. This analysis provides four estimates of total mortality. All four methods have limitations in their application to the available data, however, all could be used as an index of mortality that may be comparable over time.

Increasingly, fisheries are being managed on the basis of stocks, rather than whole-lake populations. This approach acknowledges the importance of biodiversity. No evidence has been observed to indicate that there is more than one discrete breeding stock in Kesagami Lake. Future assessment programs could attempt to identify stocks during spawning surveys. Meristic measurements and genetic techniques could also be used to describe the Kesagami Lake walleye population. Based on current information, managing the Kesagami Lake walleye population as a single stock should not reduce biodiversity if length and age distributions are maintained.

Fish Attributes for Northern Pike

Northern pike were shown to grow throughout life. Therefore, unlike the walleye population, the length distribution is sensitive to changes in population age structure and growth and may be useful to monitor changes in the population.

There does not appear to be any change in the proportion of large northern pike in the population, since 1984. Hendry and Payne (1987) noted a decrease in the proportion of fish longer than the size limit (71.0 cm TL) from 1984 (57%) to 1986 (37%) and suggested that angling pressure may be too high. This change may have been real, especially considering that the proportion remained low in 1986 (39%). Examining their results in more detail shows that the proportion caught by angling hardly changed, while trap net results changed more. Also gill net data were included in 1986. The selectivity of these gear types differs and may affect length distributions considerably. In addition, large year-to-year variability can occur, as did in 1994 and 1995. Comparing 1984 and 1986 trap net with 1994 and 1995 trap net results shows that the proportion of fish greater than the size limit was higher in 1994 and 1995 than in any previous year.

Ages of northern pike showed good age class strength in the 15 year-old and older age classes. Like walleye, scales tend to underestimate the age of older pike (Appendix 25), therefore, direct comparisons with 1984 and 1986 scale aged fish can not be made. However, the mean length of sampled pike was higher in 1994 and 1995 compared to earlier years, suggesting that the mean age of the population has not decreased.

The mean size of sampled walleye and northern pike are sensitive to the gear used and movement of large year classes through the population. Therefore, comparisons should be made within gear types and consideration be given to the effect of year class size, when interpreting changes in mean size.

The size limit for northern pike may be protecting the large fish population from harvest, however, the increase in fishing pressure and catch and release noted in 1994 and 1995 could result in loses of older age classes due to hooking mortality. The length distribution of guide-measured northern pike in 1995 was similar to that of trap net caught fish, with the exception that rounding error probably resulted in several artificially high class frequencies. Approximately 41% of guide measured fish were greater than the size limit, so anglers are returning large fish back into the waters. To maintain these older and larger classes catch and release strategies must be part of any future management plan.

Lack of a clearly defined mode may illustrate the need for a series of well represented, intermediate length (or age) classes to allow for the production and maintenance of very old, trophy fish. Casselman et al. (1995) found this to be the case for muskellunge (*Esox masquinongy*).

It is becoming increasingly difficult to continue to fund public sector fishery assessment programs as staff and provincial funding continue to be reduced. In the future, additional funding and assessment mechanisms will have to be sought by government and interested groups and individuals. Due to the pressures and the large number of anglers using catch and release, it will be imperative that age-length assessment is completed to determine the proportion and size of the largest fish in the catch and mortality rates. One relatively cheap and non-traumatic method of obtaining data could include recruiting guides and anglers to record length measurements from live-released fish. Obtaining an unbiased measured sample of released northern pike on a yearly basis should be part of ongoing assessment. Accurately measuring a northern pike at boat-side can be difficult and stressful on the fish. The use of head measurements (Head length HL) and later extrapolating to fork length measurement may be a viable alternative. These data can be placed into a mortality model that will estimate changes in mortality and recruitment (Casselman pers. comm.).

A clear plastic graduated cylinder, with a handle may be an easy way of doing this if cradles are also used? An annual sample of 200 fish would be desirable. An education package for guides and anglers may also be useful to prevent bias and imprecision and to educate contributors and designated data collectors.

In addition, several of the largest fish caught yearly should be sacrificed for detailed measurements and collection of aging structures. Anglers could sacrifice two to three large fish (950 mm in TL plus individuals) annually or if large fish are reported dead from hooking mortality by anglers or guides, then guides should be authorized to retrieve fish and collect and measure fish following established standards.

When a length distribution is available an age-length key can be used to estimate age distribution. Ricker (1975) lists conditions required for their use. An age-length key for northern pike caught in 1994 and 1995, and using fin ray ages appears in Appendix 25. An age-length key was not constructed for walleye because of the extreme amount of overlap in length-at-age for older walleye, however, this technique may be useful for angler measured pike.

A change in somatic growth rate is one of the most commonly cited and most easily measured effects of exploitation on fish population parameters. Changes in growth could be most easily detected in young fish, when growth rate is rapid and there is not as much variability as occurs in older ages and ageing techniques are more reliable. Comparison of growth rates requires unbiased samples of length at age. The current samples were collected by angling and trap nets which may exhibit size-selectivity in younger age classes. Obtaining adequate unbiased samples of walleye and northern pike should be a priority in future assessment projects.

Mortality rates for northern pike were similar between years with estimates of annual mortality ranging between 0.08 and 0.27, depending on the method used. Mortality estimates from the literature ranged dramatically from 0.19 (Mosindy et al. 1987) for an Ontario Lake to 0.36 to 0.65 for seven small lakes in Minnesota (Pierce et al. 1995) and 0.24 to 0.57 for three lakes in Michigan (Diana 1983). Our data seems to suggest that our mortality estimates for northern pike are relatively low compared to most middle latitude lakes. Presently, approximately 20% of the Kesagami Lake northern pike often die each year.

Casselman et al. (1995) estimated total mortality rates for muskellunge (*Esox masquinongy*) using the observed maximum age of fish in the population. They reported annual mortality rates of 0.16 to 0.26 for trophy muskellunge populations. Furthermore, they postulated that a decrease in maximum age from 23 to 21 was associated with an increase in annual mortality of 2% (i.e. 18% to 20%). This 2% increase in mortality resulted in an decrease in recruitment of approximately 70%. Large year classes are required to produce old, trophy muskellunge. As angling pressure increases, hooking and handling mortality associated with catch and release must be kept to a minimum (Casselman et al 1995). Kesagami Lake's northern pike stock may experience a loss of older fish in the future as a delayed response to increased mortality and smaller age class strength. Assessment of trophy fish annually and the entire population periodically (i.e. once every 10 years) is warranted.

Casselman (1978) found that northern pike grow best for length and weight at 21°C and 19°C, respectively. Kesagami Lake warms quickly, because of the shallow water, but summer water temperatures do not exceed the optimum range required for rapid growth. As a result, conditions are suitable for rapid growth of northern pike through much of the growing season. The physiological optimum temperature for walleye is 22.6°C (Hokanson 1977); slightly higher than the optimum for northern pike and the summer temperature observed in Kesagami Lake. Kesagami Lake appears to be an

excellent water body for both these top predatory fish with nearshore and shallow bay habitat restriction occurring for northern pike if temperatures rise above 23°Celsius.

As previously stated for walleye, future northern pike spawning assessments should consider recording standard length and weight measurements and meristic counts to address stock identification. Presently, managers should continue to manage this northern pike fishery as a single stock that has a wide variety of length and age classes.

Management Implications

Thompson et al. (1996) made extensive management recommendations based on the 1994 assessment program. These addressed management planning, human requirements, population assessment and research, compliance, database management and habitat protection. These are re-stated here, along with additional management recommendations, to provide a synthesis of the management issues addressed during this two year study.

Planning

Kesagami Lake Provincial Park Management Plan

The results of this study should be referenced in the park management plan. Protection of the fishery should be addressed in the management plan through establishment of targets for visitation, angling quality and fish population parameters.

Multi-management Plans, Strategies or Agreements

Lake management should be a cooperative effort of OMNR Cochrane District, Ontario Parks and user groups. Multi-management should address all fisheries and socio-economic factors in and adjacent to the park. Development outside of the park boundary must be addressed in the context of its effect on park resources. An ecosystem management approach would include aquatic resources in relation to other park resources and socio-economic factors.

Multi-management strategies could include procedures and processes to enable true power sharing, internal and external funding commitments, definition of participation and responsibilities, communication and education. The strategy should address a decision making process, resource allocations, assessment and research, human health issues, and social and economic factors.

Ontario Parks and Cochrane District should jointly assume management responsibility until user groups can commit to the management process.

Management

Resource Allocation

We recommend that the total open water angling effort not exceed 30,500 angler-hrs. This value is equal to our 1994 estimate of effort and a 12% increase from the estimated effort in 1995. This value translates to a limit of 1,500 anglers or an increase of 300 anglers over 1995 estimates. To remain within these

limits, we recommend that no additional angling effort be allocated to Kesagami Lake through the addition of new or expansion of existing tourism operations in or adjacent but with access to the Park. Northern pike is the limiting factor for the Kesagami Lake fishery. Further assessments and improved calculations for northern pike allowable yields may allow for future increases.

In addition, tourism operations within and surrounding the park and Native subsistence fishing should be considered in managing the fishery. Future discussions with users should determine allocation and compliance procedures as well as other multi-management strategies.

Fish Quality and Population Objectives

Kesagami Lake should be managed for a quality walleye and trophy northern pike fishery. We recommend that these management objectives be attained by meeting the following fish quality and population objectives:

a) Walleye: Summer angling CUE should be 0.5 fish/angler-hr or greater and total annual mortality should be less than 25% as determined using the cumulative catch curve technique. A wide age distribution should be maintained with fish 30 to 32 years of age (dorsal spine or otolith) still represented in future assessments.

b) Northern pike: Summer angling CUE should be 0.22 fish/angler-hr or greater and total annual mortality should be less than 30% as determined using the cumulative catch curve technique. In addition, a minimum of 50% of trap net caught pike should be longer than the 71 cm total length regulation. A wide age and length class should occur with good age class strength shown throughout the entire population. Such age and length distributions should ensure recruitment into the older age classes. To maintain 17 year-olds or older fish in the population, older age classes should be monitored yearly.

Review of these standards should occur every 5 years for the next 15 to 20 years to see if standards appear reasonable.

Enforcement

Kesagami Lake should be a compliance priority for District and Ontario Parks staff. Flights to the park should occur at least once during the open water and winter seasons to enforce regulations and/or to meet with tourist outfitters and anglers. Discussions concerning funding of these flights should be discussed with staff and possibly tourist outfitters.

Regulations

No additional restrictions or changes in the current seasons, catch and length regulations are recommended at this time. If ongoing assessments show a decrease in the quality of the fishery as per established standards then further regulatory changes (e.g. summer sanctuaries) for northern pike may be warranted.

Stewardship and Voluntary Management

We compliment Kesagami Lake Lodge for establishing a camp policy regarding catch and release. We recommend that other outfitters on the lake be encouraged to support similar policies. However, tourist

outfitters must be aware that catch and release can result in significant losses as a result of hooking and handling mortality - especially for northern pike. We recommend that tourist outfitters promote the use of barbless hooks, correct fish handling methods and other gear and techniques that will reduce catch and release mortality.

Information and Education

Study Results

The results of this two year study assessment should be communicated to staff and managers of Ontario Parks, Cochrane District, NELT, Kesagami Lake tourist outfitters, First Nations and other user groups. Information should be disseminated through publication of an executive summary of resource report which highlights the findings of this study. In addition, presentations should be given to staff, managers and user groups to review the results, highlight concerns and enable cooperative management of the fishery.

Fish Handling

Issues regarding catch and release mortality and proper handling techniques should be communicated to Kesagami Lake outfitters and anglers through an informational pamphlet, resource reports, videos or via training guides. Funding for these educational materials should be provided, in part, by tourist outfitters and private interests.

Regulations

We recommend that all outfitters have a supply of current Ontario Sport Fishing Regulations Summary. Enforcement and assessment staff should also have summaries available to anglers who are contacted in the field. Angler education must occur annually, since most anglers are first time visitors to the park.

Alternative Species

Lake whitefish could be promoted as an alternative species for harvest. This under-utilized species can add recreational fishing options for tourist outfitters without increasing stress on walleye and northern pike populations. Sponsoring of a professional fly fisherman is recommended to help inform and educate anglers.

Mercury Contamination

Cochrane District Office staff should review the 1994 MOEE mercury contamination findings, when they become available. The consequences of slow fish growth rates on length-based consumption guidelines should be communicated to anglers.

Population Assessment

The District and Ontario Parks should consider Kesagami Lake as a fisheries priority and staff time and some funding should be allocated annually for its management. Reduced government funding will result in present OMNR fishery managers seeking new partnerships and commitments from the users of the resource and interested parties such as industry and general public. Regardless of the funding

commitments, we propose the following assessment recommendations using minimum and advanced government and/or partnered/external funding sources.

Annual Assessment

The following assessments should be completed annually with the cooperation of user groups and with minimal government and partnered/external funding;

a. Managers should estimate the number of visitors, through post-season reports from outfitters, to determine annual angling effort. An angler diary program could be reintroduced with the cooperation of tourist outfitters, if outfitters and anglers are educated annually as to its use. Such a program could establish trends in angling pressure, species catch, harvest, consumption, size of species released, angler perceptions and needs, and/or other required data.

b. The northern pike population should be monitored on an annual basis to ensure that trophy fish are maintained. A cheap and non-traumatic method could include recruiting anglers and Kesagami Lake Lodge guides to unbiasedly record length measurements from live release northern pike. To reduce hooking and handling mortalities of measured fish and to make measurement easier, only fish head lengths (HL) should be recorded using a clear plastic, graduated cylinder with a handle. These head lengths could then be extrapolated to fork length measurements which could be used in predicting mortality and recruitment (J. Casselman pers. comm.). An annual, unbiased sample of 200 fish (100 fish minimum) is recommended.

   If this procedure can not be completed, then at least 2 to 3 large northern pike should be sacrificed each year and measured for length, weight, meristics (including total length (TL), snout length (SL), head length (HL), upper jaw length (UJ) and pectoral, dorsal and anal fin ray counts as per Hubbs and Lagler 1958), sex, age (including, celithera, fin ray and scales), condition and other attributes. Only the very largest fish should be used (i.e. in excess of 1,000 mm), since the objective is to measure if the lake's oldest aged fish are being reduced. Anglers should be encouraged to report and guides should be encouraged to collect fresh fish that have succumbed to handling or hooking mortality.

c. An educational/training package could be developed to ensure quality control and that proper handling and specimen collection techniques are followed. A video of these or other partnered assessments may prove useful.

Ten Year Assessment

Long term assessment should be incorporated into any fishery strategy for Kesagami Lake Provincial Park. To complete this monitoring program will involve all interested parties with alternative funding mechanisms being considered. If additional funds are available, the following should be completed;

a. A detailed two year assessment of this fishery should occur once every 10 years. Methods should follow this report and include both creel and index netting assessments. We recommend that the creel survey methods be reviewed. Conducting roving and access surveys reduces the time available for working trap nets. A cooperative creel conducted with the Kesagami Lake Lodge should be considered.

b. During the two year assessment, biological samples from walleye and northern pike in the 1 - 5 year old age classes should be obtained to establish better estimates of growth. Samples must be collected in a manner such that size selection does not occur. We suggest that a series of seine net locations be used based on trap net locations to obtain these samples, as well as to establish an index of the small fish population.

Database Management

A permanent Kesagami Lake database has been established for the Kesagami Lake fishery. Storage of data should continue to occur at the District office and involve written and computer storage, as well as maintenance of this information. Fish attribute data from 1994 and 1995 should be stored in database files using FISHNET data standards. These data are currently in spreadsheets and could be easily converted (see 1995 data book). Fish attribute data from 1984 and 1986 should be computer entered in FISHNET format. These data are currently not available in a computer format.

Research

Hooking Mortality

Hooking mortality rates for northern pike should be determined. Factors examined should include; hook size, gear type, hook location, handling technique, fish size, water depth, water temperature and other habitat indicators. Research should determine the effect of catch and release on short and long term mortality and effects on fish physiology and behaviour. Studies should be conducted on Kesagami Lake and other adjacent and regional waterbodies. Possible partners could include; Ontario Parks, OMNR Cochrane District, Northeast Science and Technology, universities, First Nations, private enterprises and other user groups.

Other

Additional research in areas relevant to the Kesagami Lake fishery should be supported. These could include; multi-management planning, allocation determination and compliance and fish community studies.

Habitat Management

Sanctuaries

At this time we do not recommend that additional spawning sanctuaries for walleye or northern pike be established.

Assessment

We recommend that critical walleye and northern pike spawning areas be identified and mapped during future assessment programs.

CONCLUSION

The Kesagami Lake fishery was found to have an estimated fishing pressure of between 27,308 and 30,500 angling-hrs or approximately 1.5 angler-hrs/ha which is an increase of over 10,000 angler-hrs since 1987. Presently this angling pressure is not considered detrimental to the sustainability of the fishery. Walleye and northern pike harvests are well within the total potential yield for Kesagami Lake, however, an estimated 6,000 to 7,500 northern pike are caught and released annually. If hooking mortalities reach 10% or greater, especially for small and large trophy sized fish, then the trophy northern pike fishery may be in jeopardy. Consecutive age class representation throughout the northern pike population must be maintained to ensure recruitment into the trophy size classes. Walleye growth tended to be slow with more normal growth patterns seen for northern pike for this portion of Ontario. Wide age and length distributions were present in both populations. Presently, walleye and northern pike populations remain healthy with high quality fishing for both species. Present angler dynamics were similar to past years with much of the angling activity occurring through the tourist outfitters. Future management strategies include; establishing and monitoring the proposed 30,500 angler-hrs/yr (1,500 anglers/yr) allocation; continuing to fund, through government and partnered funds, low cost annual and periodic (i.e. every 10 years) assessments and managing the fishery within an ecosystem framework using a multi-management approach that includes, tourist outfitters, First Nations of Ontario, OMNR Cochrane District and Ontario Parks staff and interested public and involving both natural science and socio-economic principles.

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TABLES

Table 1. Estimated and observed angling effort reported by roving and access creel surveys Kesagami Lake 1995.

						Observed	Estimated		
Survey type	Survey space	No. of anglers	No. of interviews	No. of counts	Mean activity counts	Effort angler-hrs	Effort angler-hrs	SE	95% CI
Roving	Southeast	183	77	18	4.3	849	10430	1835	3597
	Southwest	278	125	26	3.7	1011	8488	1445	2832
	North	236	95	30	3.4	937	8632	1320	2587
	Total	697	294	74	3.7	2798	27308	2698	5288
Access	Total	692	297	47	12.2	5303	16999	872	1709

Table 2. Angler effort, catch and harvest of walleye estimated from roving and access creel surveys Kesagami Lake 1995.

		Observed	Estimated	Observed				Estimated							
Survey type	Survey space	Effort angler-hrs	Effort angler-hrs	Caught	Harvested	CUE	HUE	Caught	SE	95% CI	Harvested	SE	95% CI	CUE	HUE[a]
Roving	Southeast	849	10430	340	70	0.40	0.08	5654	2608	5122	1824	851	1688	0.54	0.17
	Southwest	1011	8488	848	187	0.84	0.18	6981	1892	3708	2025	455	892	0.82	0.24
	North	937	8632	538	66	0.57	0.07	4837	1736	3403	469	132	259	0.56	0.05
	Total	2798	27308	1726	323	0.62	0.12	17255	3663	7179	4318	974	1909	0.63	0.16
Access	Total	5303	16999	3953	307	0.74	0.06	13580	1613	3161	1064	119	223	0.80	0.06

[a]Estimated harvest/effort (HUE) was based on the number of walleye harvested.

Table 3. Angler effort, catch and harvest of northern pike estimated from roving and access creel surveys Kesagami Lake 1995.

		Observed	Estimated	Observed				Estimated							
Survey type	Survey space	Effort angler-hrs	Effort angler-hrs	Caught	Harvested	CUE	HUE	Caught	SE	95% CI	Harvested	SE	95% CI	CUE	HUE[a]
Roving	Southeast	849	10430	163	0	0.19	0.00	1826	338	662	0	0	0	0.18	0.00
	Southwest	1011	8488	196	0	0.19	0.00	2140	717	1405	0	0	0	0.25	0.00
	North	437	8632	257	0	0.27	0.00	2587	567	1111	0	0	0	0.30	0.00
	Total	2798	27308	616	0	0.22	0.00	6336	973	1907	0	0	0	0.23	0.00
Access	Total	5303	16999	1266	6	0.24	0.001	4039	263	515	25	15	29	0.24	0.001

[a]Estimated harvest/effort (HUE) was based on the number of northern pike harvested.

Table 4. Total estimated and observed angling effort reported for roving and access creel surveys Kesagami Lake 1994 - 1995.

					Observed	Estimated		
Survey type	No. of anglers	No. of interviews	No. of counts	Mean activity counts	Effort angler-hrs	Effort angler-hrs	SE	95% CI
1994								
Roving	492	202	56	3.6	2491	17951	2122	4159
Access	923	372	66	17.0	8029	25815	346	678
1995								
Roving	697	294	74	3.7	2798	27308	2698	5288
Access	692	297	47	12.2	5303	16999	872	1709

Table 5. Summary of creel surveys and associated best estimates of angling effort, catch, harvest and catch per unit effort Kesagami Lake 1984 - 1995.

				Walleye				Northern Pike			
Year	Type	Creel Period	Effort ang-hr	Catch #	Harvest #	CUE #/ang-hr	HUE #/ang-hr	Catch #	Harvest #	CUE #/ang-hr	HUE #/ang-hr
1984[a]	Access	June 11 - June 18	1015	601	296	0.59	0.29	376	55	0.38	0.05
1985[b]	Access	June 3 - Aug. 9	1656	1618	607	0.98	0.37	490	121	0.30	0.07
1986[c]	Access	May 18 - Sept. 21	12911	9766	3847	0.76	0.20	2867	518	0.22	0.04
1994[d]	Acc/Rov	June 9 - Aug. 11	30500	24900	2640	0.82	0.09	9100	170	0.30	0.01
1995[e]	Acc/Rov	May 29 - Aug. 13	27308	17255	4318	0.63	0.16	6336	25	0.23	0.00

[a]1984: Conducted for short period to obtain CUE estimates. Observed values only.
[b]1985: Incomplete coverage. Observed values only.
[c]1986: Estimated totals extrapolated from June 19 to July 23 creel period.
[d]1994: Effort is 'best' estimate of pooled data. CUE/HUE are from access creel.
[e]1995: Effort, catch and CUE/HUE are from roving creel. Northern pike harvest is from access creel.

Table 6. Angling methods used as reported by roving and access creel surveys Kesagami Lake 1994 - 1995.

	Roving Creel Survey						Access Creel Survey					
	No. of anglers[a]		Percent		Rank		No. of anglers[a]		Percent		Rank	
Fishing Method	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995
Jigging	53	62	10.8	8.9	4	4	120	57	13.3	8.2	4	4
Drift	2	27	0.4	3.9	5	5	18	13	2.0	1.9	5	5
Troll	135	132	27.4	18.9	2	3	213	83	23.6	12.0	3	3
Spin cast	243	266	49.4	38.2	1	1	300	267	33.2	38.6	1	2
Fly cast	2	0	0.4	0.0	5	6	1	2	0.1	0.3	6	6
Combination	57	210	11.6	30.1	3	2	252	270	27.9	39.0	2	1
Total	492	697	100	100			904	692	100	100		

[a]Number of anglers include guides and visiting anglers for first time trips and multiple fishing trips.

Table 7. Angler origin by creel survey Kesagami Lake 1994 - 1995.

	Roving				Access			
	1994		1995		1994		1995	
Origin	No. of anglers	% anglers	No. of anglers	% anglers	No. of anglers	% anglers	No. of anglers	% anglers
Local	--	--	--	--	--	<1	--	--
Ontario	71	29	115	28	90	30	129	34
Canada	5	2	1	<1	4	1	3	1
United States	166	69	297	72	204	68	247	65
Other	--	--	--	--	--	--	--	--

Table 8. Angler visitor code by creel survey Kesagami Lake 1994 - 1995.

	Roving				Access			
	1994		1995		1994		1995	
Visitor Code	No. of anglers	% anglers	No. of anglers	% anglers	No. of anglers	% anglers	No. of anglers	% anglers
Non-permanent resident	5	2	11	3	9	3	11	3
Day tripper	7	3	48	12	4	1	--	--
Camper Provincial Park	--	--	6	1	--	--	15	4
Other paid	225	95	351	84	288	96	402	94

Table 9. Number of anglers estimated to visit Kesagami Lake, by outfitter/place of accommodation and percent use by outfitter, based on roving and access creel surveys, outfitters reports and estimated angler efforts for Kesagami Lake 1994 - 1995.

	Roving Survey				Access Survey				Outfitter Estimate[a]				Rank		Best Estimates[b] % use		Rank	
	No. of anglers		% anglers		No. of anglers		% anglers		No. of anglers		% anglers							
Outfitter Name	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994	1995	1994 %	1995 %	1994	1995
Kesagami Lake Lodge	162	607	83.1	87.1	288	684	98.0	98.8	899	577	61.8	48.2	1	1	83.1	87.1	1	1
Lindbergh's	26	60	13.3	8.6	--	--	--	--	250	270	17.2	22.6	2	2	7.6	5.6	2	2
Konopelky Air Service	2	27	1.0	3.9	2	2	0.7	0.7	150	200	10.3	16.7	3	3	4.6	4.2	3	3
Other - Private	5	3	2.6	0.4	4	8	1.4	1.2	134	99	9.2	8.3	4	4	4.1	2.1	4	4
Gardner Outfitters	--	--	--	--	--	--	--	--	14	48	1.0	4.0	5	5	0.4	1.0	5	5
Bushland Airways	--	--	--	--	--	--	--	--	8	3	0.6	0.3	6	6	0.2	0.06	6	6
Total	195	697	100	100	294	692	100	100	1455	1197	100	100			100	100		

[a]Outfitters and camp operators were contacted after the fishing season to obtain their best estimate of number of anglers accommodated. Other/private estimate was based on park landing permits and assuming one landing per permit with the 1994 data recalculated to include pilot and passengers for total number of anglers.

[b]Best estimates based on number of anglers and angler effort exerted by each angler group represented for each outfitter. For 1995, we assumed Kesagami Lake Lodge contributed approximately 87.1% of the anglers or 23,785 angler-hrs (87.1% of 27,308 angler-hrs). Best estimates from outfitter estimates were calculated for the remaining outfitters {e.g. Lindbergh 270 anglers in 1995 contributed 1,536 angler-hrs [43.6% (270/620) of 3,523 angler-hrs (27,308 - 23,785)] of the 27,308 angling effort, Lindbergh's 1,536 angler-hrs contributed 5.6% of the total as shown in table}.

Table 10. Observed number of years anglers have been visiting Kesagami Lake Provincial Park by creel survey 1994 - 1995.

	Roving creel survey				Access creel survey[a]			
	1994		1995		1994		1995	
No. of years.	No. of anglers	% anglers	No. of anglers	% anglers	No. of anglers	% anglers	No. of anglers	% anglers
1	121	62	204	61	245	83	233	61
2	39	20	57	17	22	7	71	19
3	7	4	13	4	9	3	15	4
4	4	2	1	<1	2	1	4	1
5	16	3	5	1	0	0	4	1
>5	18	9	55	16	18	6	54	14
Total	195	100	335	100	296	100	381	100

[a]The access creel was heavily biased towards the Kesagami Lake Lodge angler for the access point was the Lodge's main dock area which is rarely used by other outfitters and involves no anglers that access the park at other locations.

Table 11. Shore lunch walleye consumption reported by roving and access creel surveys 1994 - 1995.

Survey type	No. of anglers	No. of anglers questioned	Anglers that consumed fish		Observed no. of fish eaten	Observed harvest	Consumption rate	Best harvest estimate[a] no.	Mean weight[a] kg	Estimated total fish consumption	
			#	%						#	kg
1994											
Roving	492	436	134	30.7	168[b]	241	69.7	2640	0.60	1840	1104
Access	923	876	340	38.8	564	734	76.8	2640	0.60	2028	1217
1995											
Roving	697	599	115	19.2	106	281[c]	37.7	4318	0.61	1628	993
Access	692	602	208	34.6	210	277[c]	75.8	4318	0.61	3273	1997

[a]Best harvest estimate for 1994 was considered the pooled estimate of 2,640 walleye with mean weight of 0.60 kg for an estimated total weight of 1,584 kg (Thompson et al. 1996). Our best harvest estimate for 1995 was the roving creel estimate of 4,318 and mean weight of 0.61 (Table 13.).

[b]Note that this value is slightly larger that the 161 reported by Thompson et al. (1996). We recalculated this value and have included 7 additional fish into this calculation for a consumption rate slightly higher than previously reported.

[c]The 1995 observed harvest was less than reported in Table 2 for only 86% of observed anglers reported results.

Table 12. Proportion of anglers aware of fishing regulations and whose camp had a fishing policy Kesagami Lake 1994 - 1995.

	1994		1995	
Attribute	Roving	Access	Roving	Access
Aware	144 (74)[a]	182 (64)	320 (92)	339 (100)
Not Aware	51 (26)	103 (36)	28 (8)	--
Policy	177 (91)	244 (96)	263 (97)	292 (100)
No Policy	18 (9)	11 (4)	8 (3)	--

[a]Values represented includes observed number of anglers with percent of total in brackets.

Table 13. Comparison of estimates of harvest, total losses and total potential yield (TPY) for walleye and northern pike Kesagami Lake 1994 - 1995.

Species by year	No. caught	No. harvested	Mean weight kg[a]	Weight harvested kg	Weight removed kg[b]	TPY SPOF kg/ha/yr[c]	TPY SPOF kg/yr[c]	TPY % used	TPY NW kg/ha/yr[d]	TPY NW kg/yr[d]	TPY % used
Walleye											
1994	24900	2640	0.60	1584	2252	0.79	13500	16.7	0.55	9400	24.0
1995	17255	4318	0.61	2634	3029	0.79	13500	22.4	0.55	9400	32.2
Northern Pike											
1994	9100	170	3.29	559	2028 (3497)	0.62	10600	19.1 (33)	0.25	4300	47.2 (81.3)
1995	6336	25[e]	3.29	82	1120 (2158)	0.62	10600	10.6 (20.4)	0.25	4300	26.1 (50.1)

[a]Mean weight is of angled fish only for walleye and angled and trap netted fish for northern pike, as very few angled northern pike were measured. Used 1995 mean northern pike weights for 1994 calculations.

[b]Total weight removed includes losses to hooking mortality of released fish (5% for walleye and 5 and 10% for northern pike). The value in brackets incorporated the 10% hooking mortality.

[c]Total potential yield estimate based on OMNR SPOF #12 report and using a lake surface area of 17,120 ha. and rounding to the nearest 100.

[d]Total potential yield estimate based on the Northwest Region Technical Sub-committee on Recreational Fishing Quality (OMNR 19?2) and calculated as c above.

[e]Used access creel northern pike harvest data for no harvest was represented for the roving creel data, since so few northern pike are harvested annually.

Table 14. Trap net total catch by species, catch per set and percent catch composition Kesagami Lake 1994 - 1995.

			Species						
Year	Season	Statistic	Lake Whitefish	Lake Herring	Northern Pike	Longnose Sucker	White Sucker	Yellow Perch	Walleye
1994	Spring[a]	n	12	12	12	12	12	12	12
		Total catch	75	17	78	34	257	1	238
		Mean	6.3	1.4	6.5	2.8	21.4	0.1	19.8
		LCL[b]	2.6	0.5	2.8	-0.7	3.9	-0.1	5.7
		UCL[b]	9.9	2.4	10.2	6.4	39.0	0.3	34.0
		%	10.7	2.4	11.1	4.9	36.7	0.1	34.0
	Summer	n	35	35	35	35	35	35	35
		Total catch	223	96	90	42	115	13	101
		Mean	6.4	2.7	2.6	1.2	3.3	0.4	2.9
		LCL[b]	2.8	1.3	1.5	0.6	1.9	0.1	1.8
		UCL[b]	9.9	4.2	3.7	1.8	4.6	0.6	4.0
		%	32.8	14.1	13.2	6.2	16.9	1.9	14.9
1995	Spring	n	12	12	12	12	12	12	12
		Total catch	48	12	97	12	126	2	112
		Mean	4.0	1.0	8.1	1.0	10.5	0.2	9.3
		LCL[b]	0.9	-0.4	1.8	-0.2	3.7	-0.1	5.2
		UCL[b]	7.1	2.4	14.3	2.2	17.3	0.4	13.5
		%	11.7	2.9	23.7	2.9	30.8	0.5	27.4
	Summer	n	33	33	33	33	33	33	33
		Total catch	27	24	111	18	120	24	177
		Mean	0.8	0.7	3.4	0.5	3.6	0.7	5.4
		LCL[b]	0.2	0.3	2.1	0.3	2.0	0.3	2.2
		UCL[b]	1.5	1.1	4.6	0.8	5.3	1.2	8.6
		%	5.4	4.8	22.2	3.6	24.0	4.8	35.3

[a]Two spring net sets in 1994 were daytime sets only, all others were overnight sets.
[b]Statistics represented 95% lower confidence level (LCL) and upper confidence (UCL).

Table 15. Comparison of average fork length, round weight and age of trap net caught and angled walleye and northern pike Kesagami Lake 1984 - 1995.

			Fork Length			Round Weight			Age			
Species	Year	Gear	n	mean	95% CI[a]	n	mean	95% CI	n	mean	95% CI	Primary age structure[b]
Walleye	1984	TN	512	372.0	73.5	512	553.5	424.9	195	9.2	3.9	SC
	1985	TN	907	373.1	92.7	704	534.0	443.6	696	9.7	4.8	SC
	1986	TN	481	353.3	100.7	481	451.2	423.4	444	8.8	5.5	SC
	1994	TN	240	388.2	6.7	238	648.8	46.8	237	16.7	0.8	DS
	1995	TN	266	356.7	8.1	266	509.6	39.6	266	11.9	0.8	DS
	1984	AN	--	385	--	--	578	--	--	11	--	SC
	1985	AN	91	384.6	86.6	91	575.3	463.0	89	10.6	2.2	SC
	1986	AN	211	393.9	62.7	211	602.8	309.5	210	10.9	3.1	SC
	1994	AN	104	386.1	7.6	104	633.6	36.2	104	14.0	1.1	DS
	1995	AN	245	386.3	5.3	245	607.4	24.3	245	14.1	0.7	DS
Northern Pike	1984	TN	134	684.2	332.6	132	3040.9	4456.0	131	8.9	6.9	SC
	1985	TN	271	676.8	80.9	249	2445.1	3675.1	249	4.7	3.5	SC
	1986[c]	TN/GN	122	613.5	365.3	122	2388.1	4502.0	79	7.5	7.0	CL
	1994	TN	154	759.4	29.5	152	4197.2	443.0	151	10.0	0.6	PFR
	1995	TN	185	700.2	26.9	184	3283.0	373.8	183	8.7	0.6	PFR

[a]1984-86: Confidence intervals were calculated as 1.96* S.E. value given in reports and multiplying by 10 to change to mm. The values appear to be incorrect but raw data were not reviewed.

[b]Primary age structures used include scale (SC), dorsal spine (DS), cleithra (CL) and pectoral fin ray (PFR).

[c]1986: Data for trap net and gill net caught northern pike were only available in combined form. Sample sizes were: TN n=108, GN n=14.

Table 16. Mortality rate[a] estimates for walleye and northern pike for Kesagami Lake 1984 - 1995.

	1984		1986		1994		1995	
Method[b]	Z	A	Z	A	Z	A	Z	A
Walleye[c]								
Catch curve					0.05	0.05	0.08	0.07
Cumulative catch curve					0.21	0.19	0.23	0.20
Robson-Chapman					0.10	0.10	0.13	0.12
Maximum age					0.15	0.14	0.14	0.13
Ages used					8-29		9-27 (32 for maximum age)	
Northern Pike[d]								
Catch curve	0.17	0.15	0.16	0.15	0.09	0.08	0.15	0.14
Cumulative catch curve	0.34	0.29	0.32	0.27	0.29	0.25	0.32	0.27
Robson-Chapman	0.21	0.19	0.21	0.19	0.17	0.16	0.23	0.21
Maximum age	0.26	0.23	0 26	0.23	0.25	0.22	0.23	0.21
Ages used	6-17		6-13		6-18		8-19	

[a]Mortality rates expressed include, instantaneous mortality rate (Z) and annual mortality rate (A).
[b]Methods include catch curve analysis (Ricker 1975 p. 33), cumulative catch curve (R. Korver pers. comm.), Robson-Chapman (Ricker 1975 p. 31) and maximum age (Pauly 1984 p.53)
[c]Walleye mortality rates based on trap net and angling data combined for 1994 and 1995.
[d]Northern pike mortality rates based on trap net data only for 1984 and 1995, trap net and angling data combined for 1994 and trap net, gill net and angling data combined for 1986 using cleithrum ages.

FIGURES

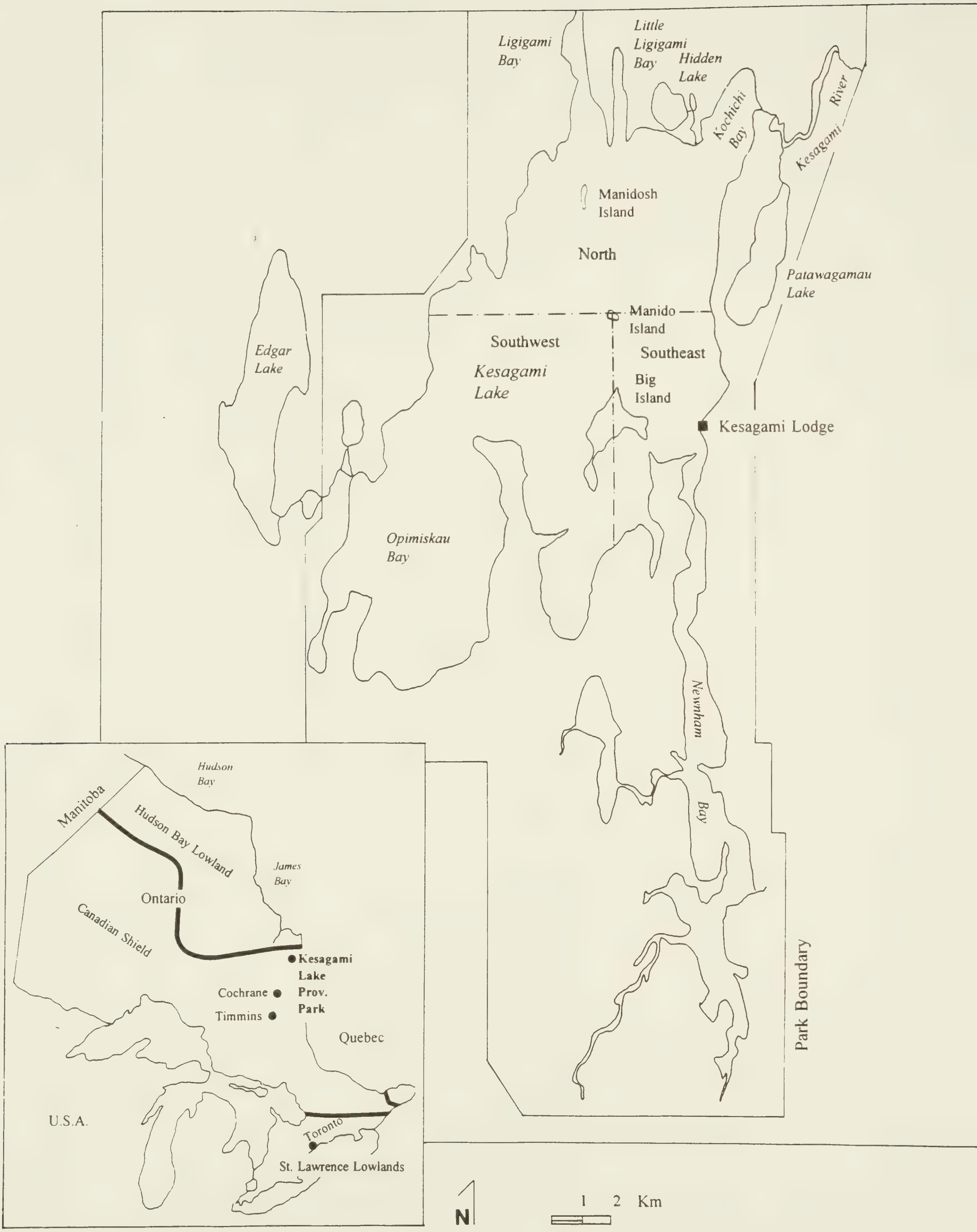


Fig. 1. Kesagami Lake Study Area.

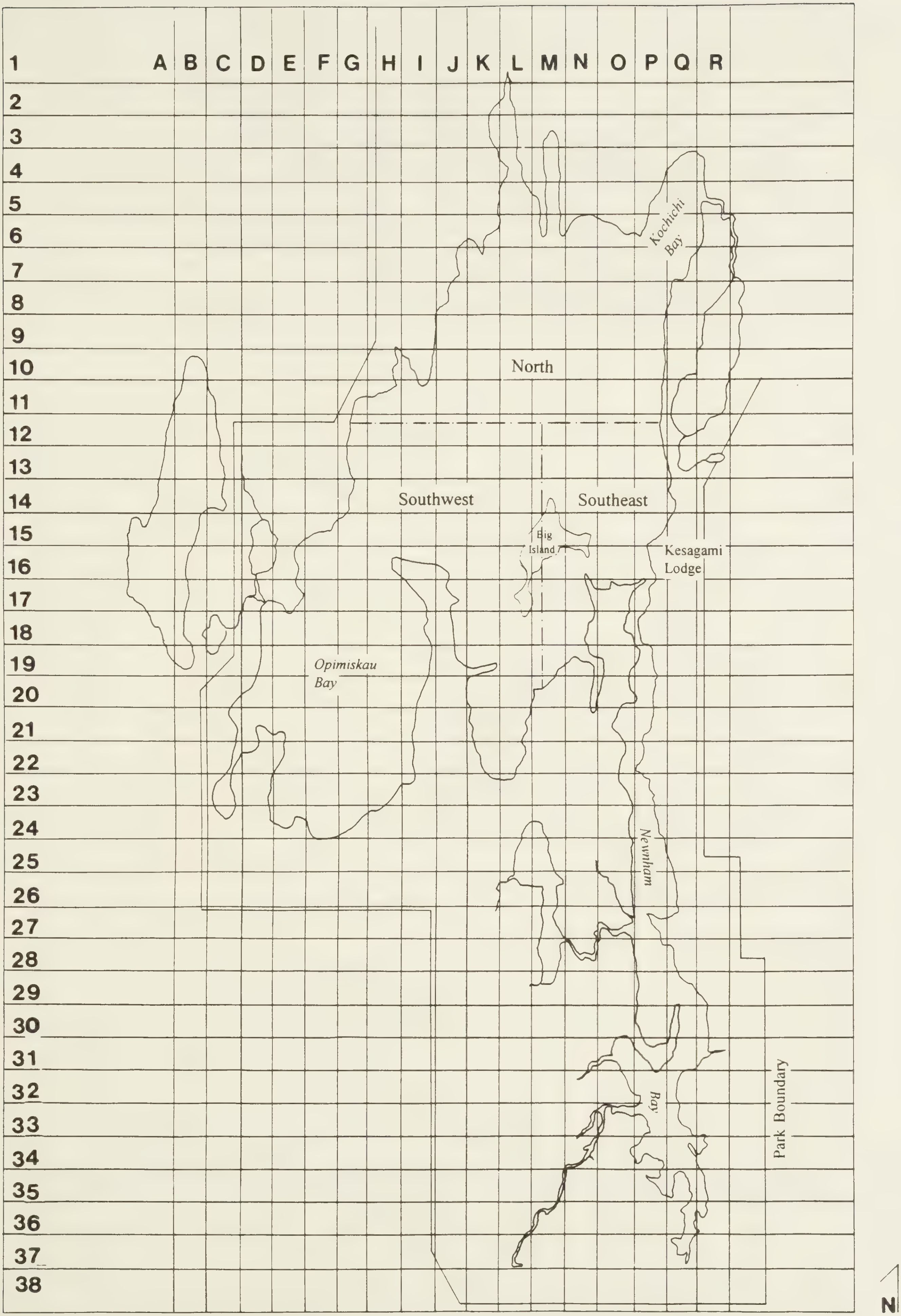


Fig. 2. Kesagami Lake fishing location 1 km sq. grids used during the 1994 and 1995 angler surveys. Area sectors shown used in 1995 only.

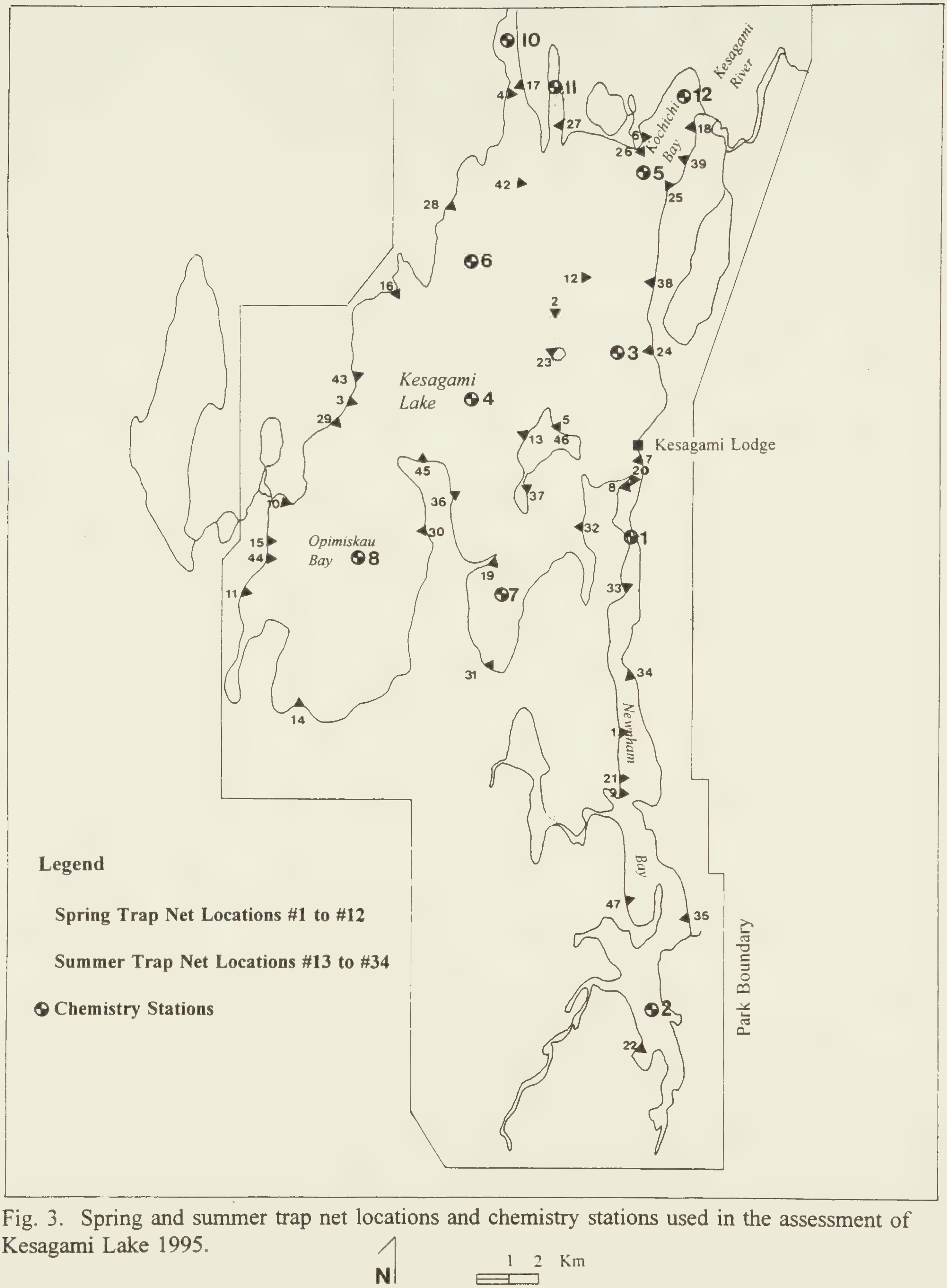


Fig. 3. Spring and summer trap net locations and chemistry stations used in the assessment of Kesagami Lake 1995.

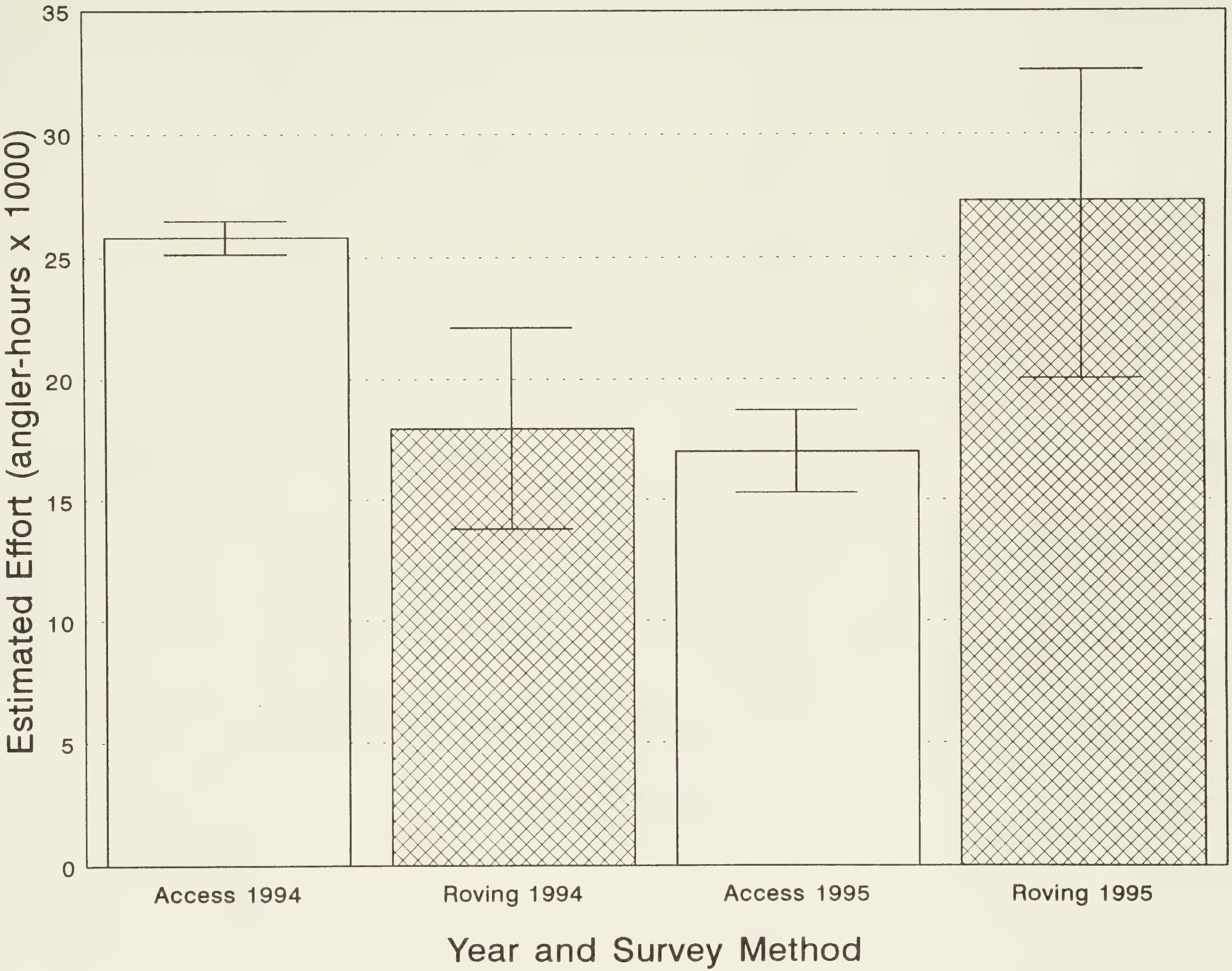


Fig. 4. Comparison of angler effort by survey type and year for Kesagami Lake 1994 and 1995.

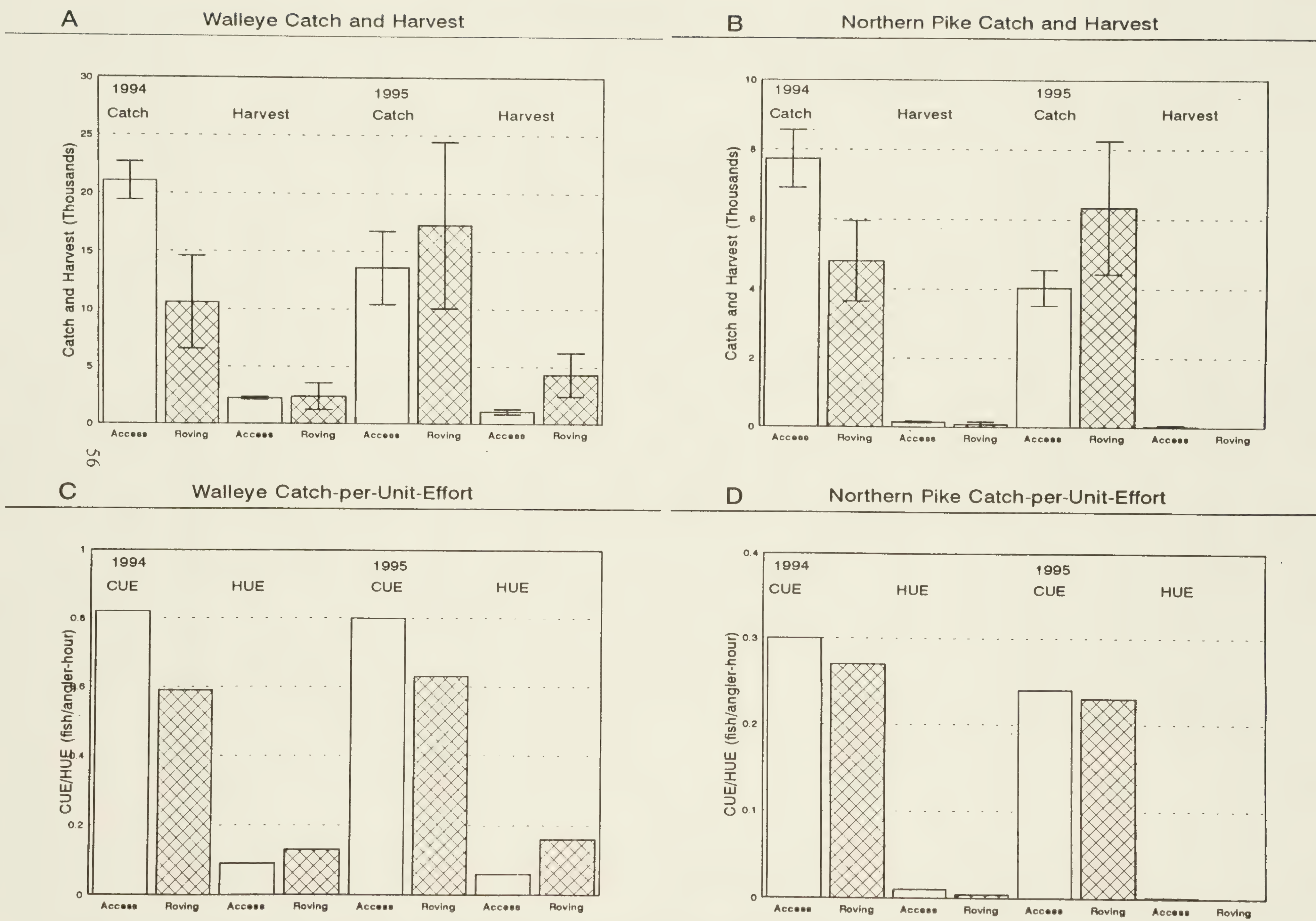


Fig. 5. Catch, harvest, CUE and HUE for walleye and northern pike from access and roving creels, Kesagami Lake 1994 and 1995.

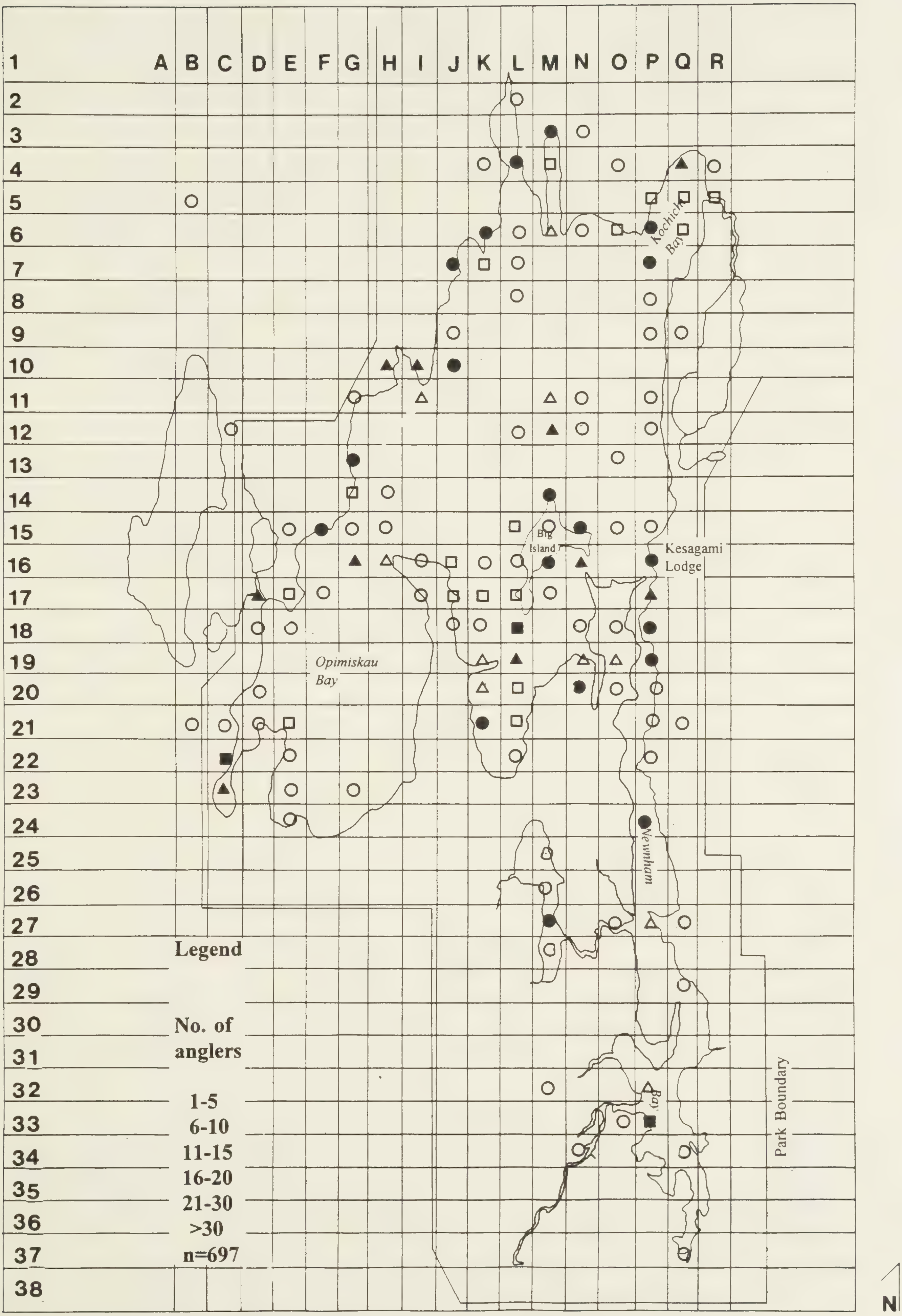


Fig. 6. Reported areas of fishing pressure from the roving creel survey for Kesagami Lake 1995.

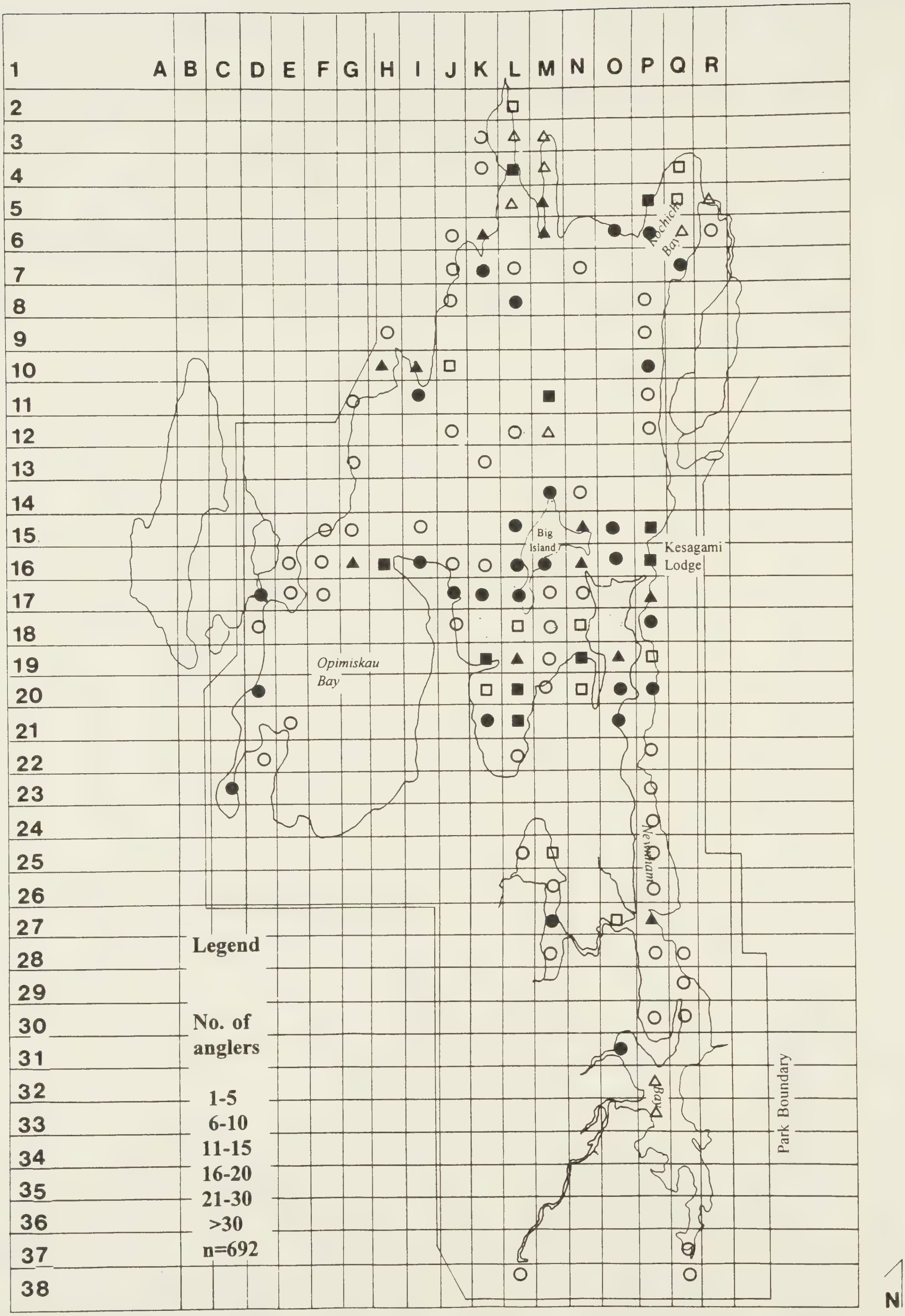


Fig. 7. Reported areas of fishing pressure from the access creel survey for Kesagami Lake 1995.

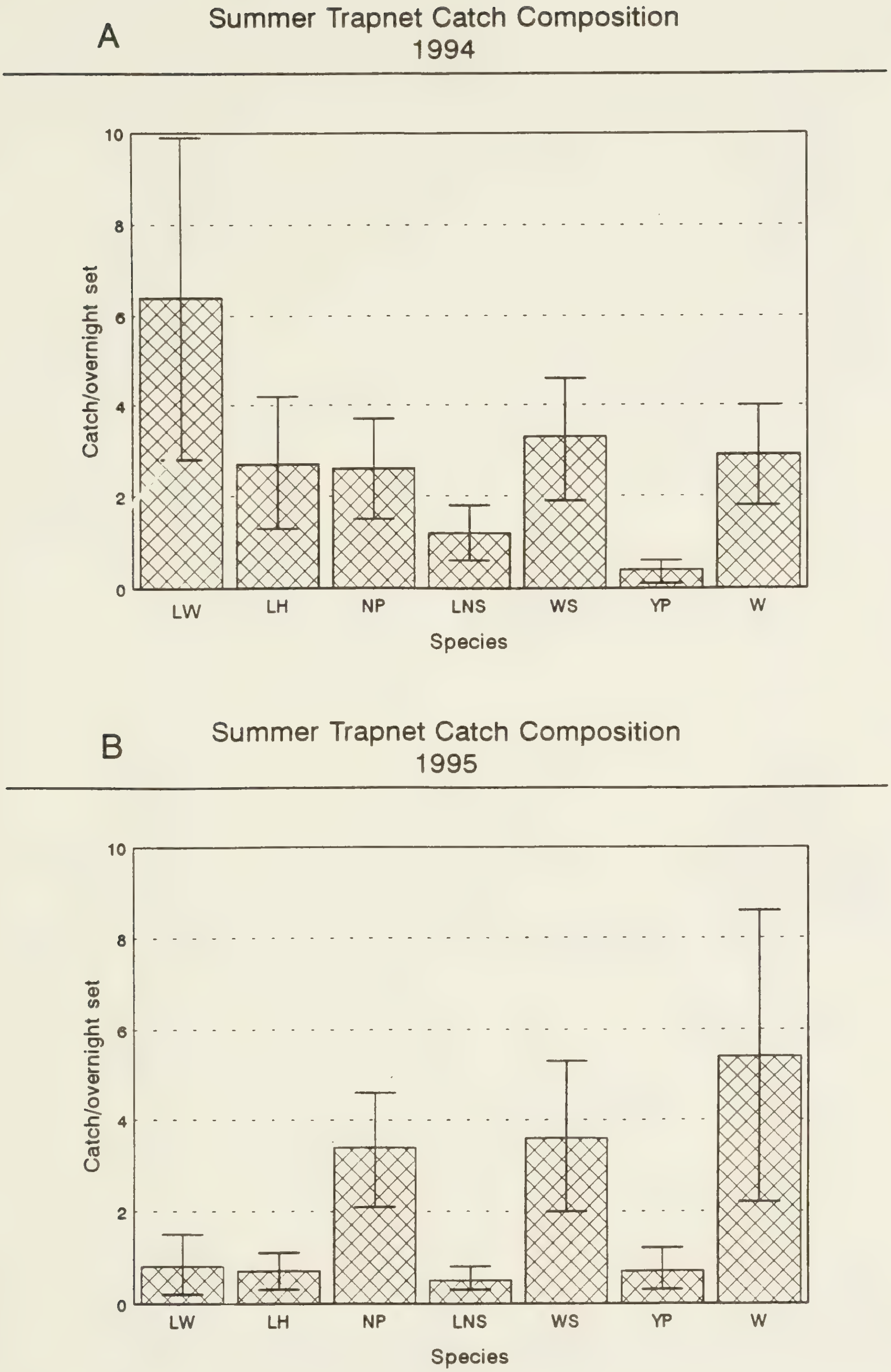


Fig. 8. Summer trap net catch composition for Kesagami Lake nearshore fishery assessment 1994 and 1995. Species codes are as follows; Lake Whitefish (LW), Lake Herring (LH), Northern Pike (NP), Longnose Sucker (LNS), White Sucker (WS), Yellow Perch (YP) and Walleye (W).

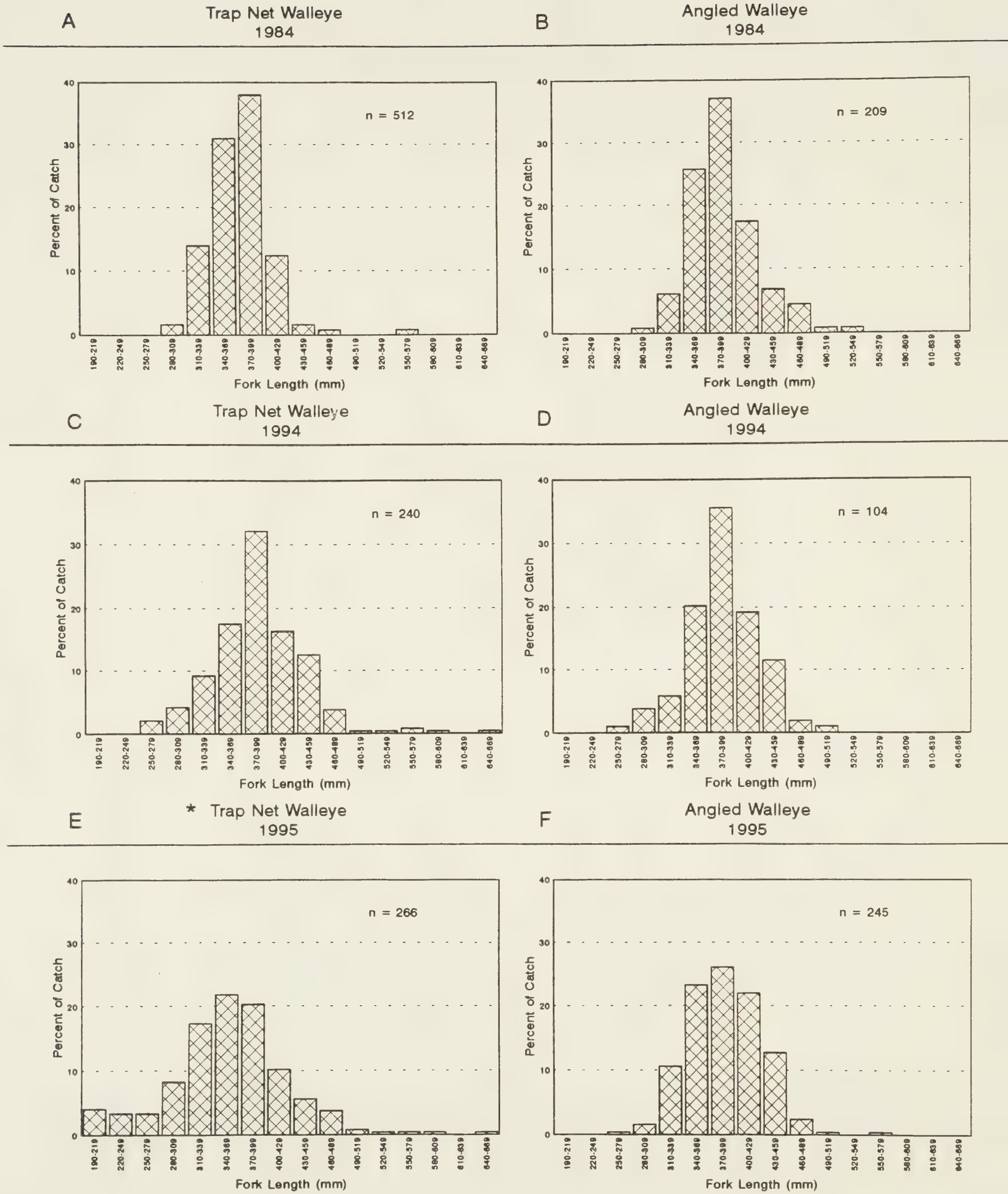
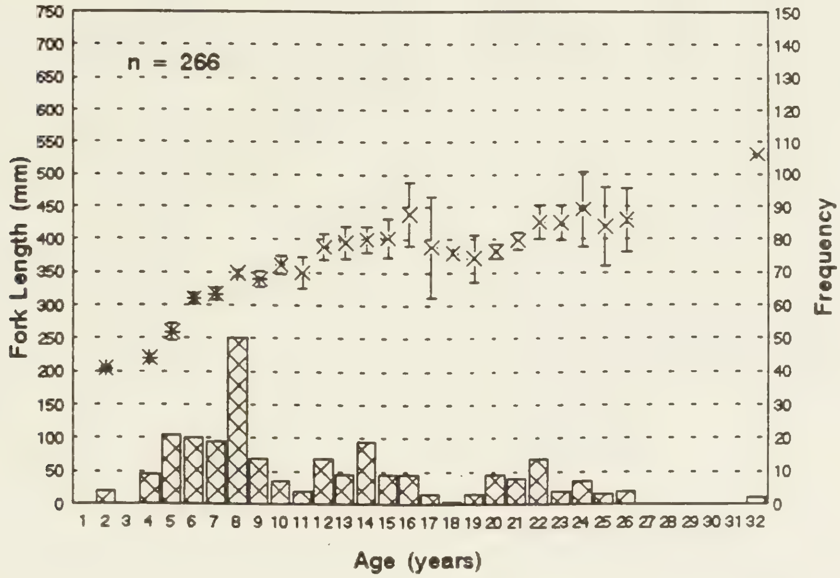


Fig. 9. Fork length frequency distributions, by percent of catch, for trap netted and angled walleye for Kesagami Lake, 1984-95. Star symbol (*) denotes a significant difference (Kolmogorov - Smirnov test, p<0.05).

Walleye (Trap Net)
1995



Walleye (Angled)
1995

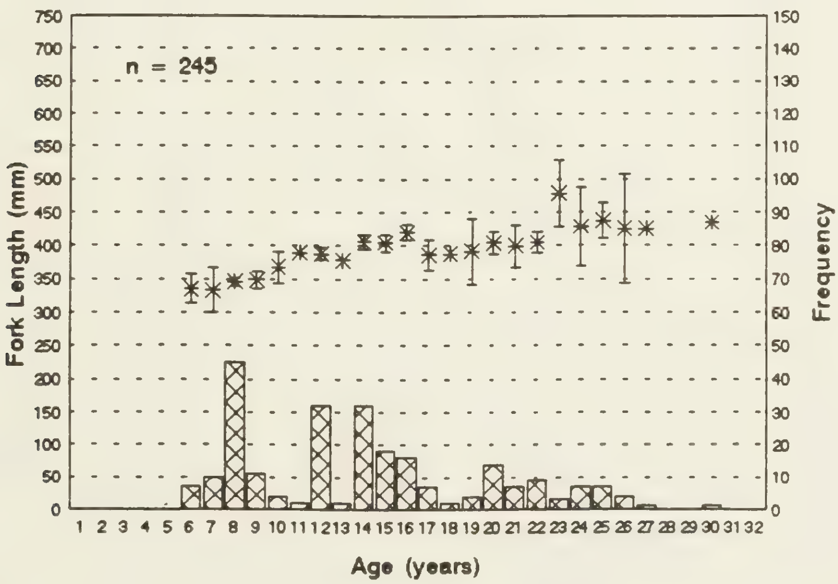


Fig. 10. Age distribution and growth curve for trap netted and angled walleye for 1995.

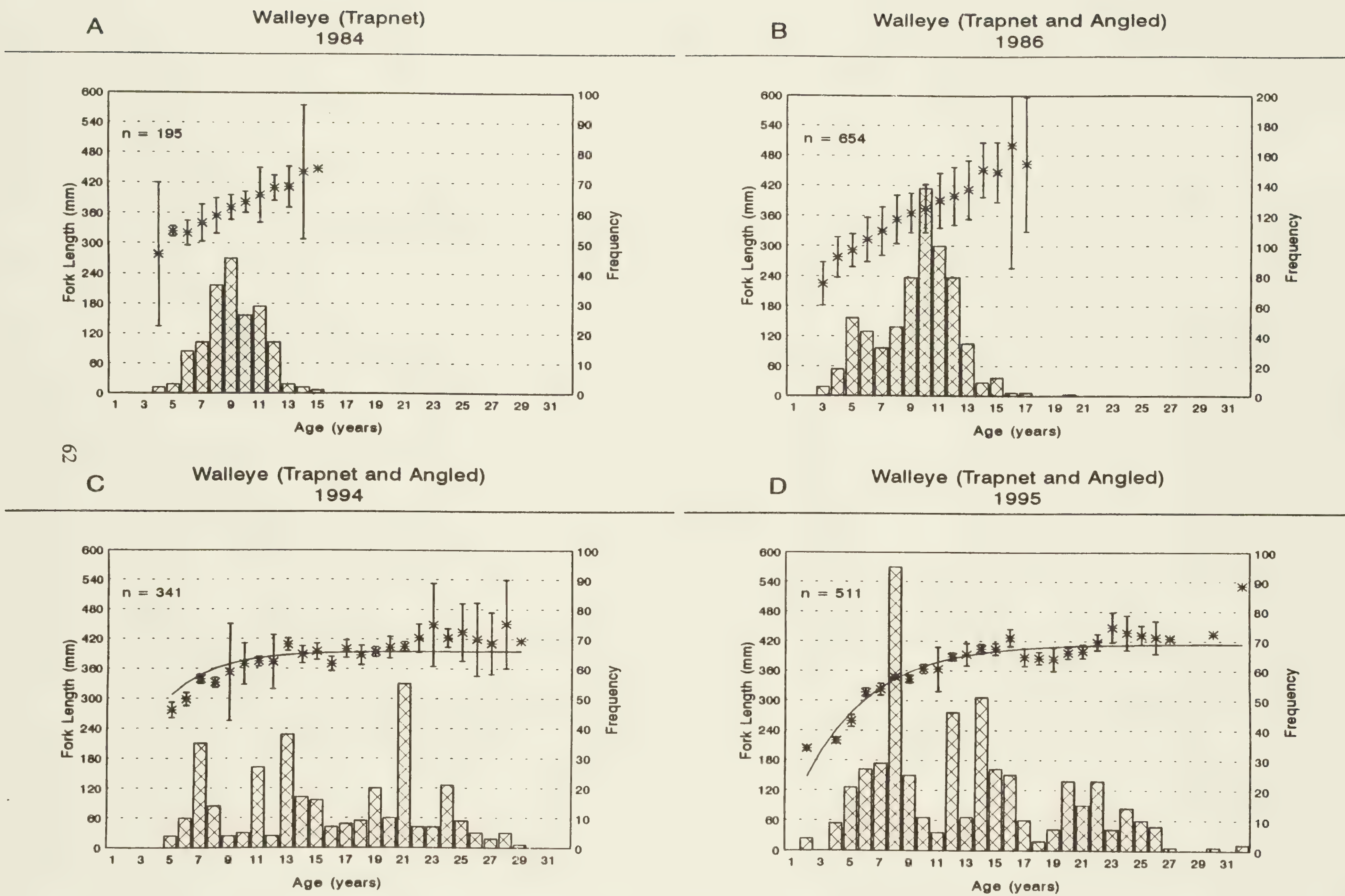


Fig. 11. Age distribution and growth curves for trap net and angled walleye combined for 1986, 1994 and 1995 and trap net data for 1984. Growth curves used mean fork length at age with corresponding 95% confidence intervals.

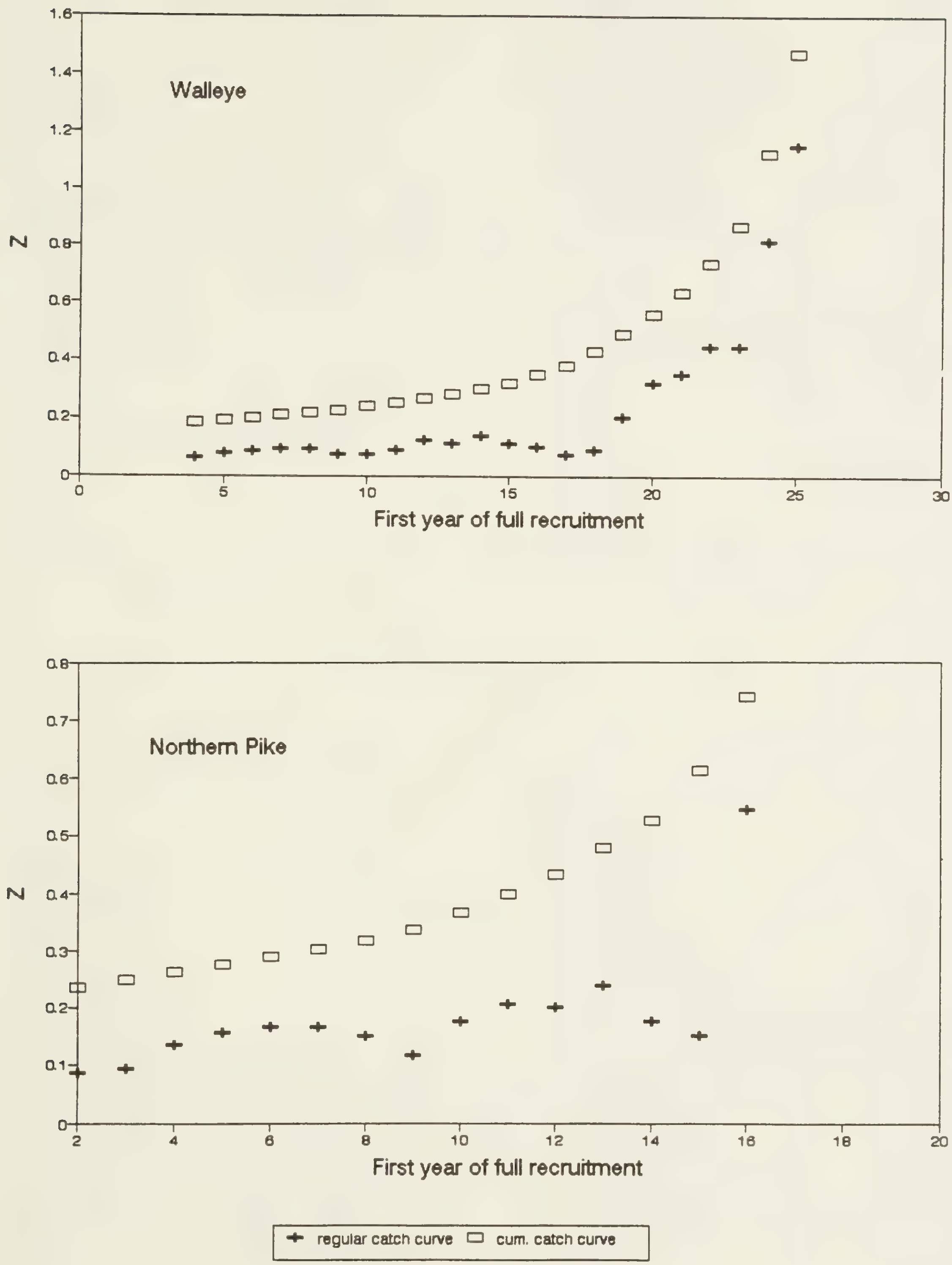


Fig. 12. Analysis to determine sensitivity of age of full recruitment for a variety of Z values.

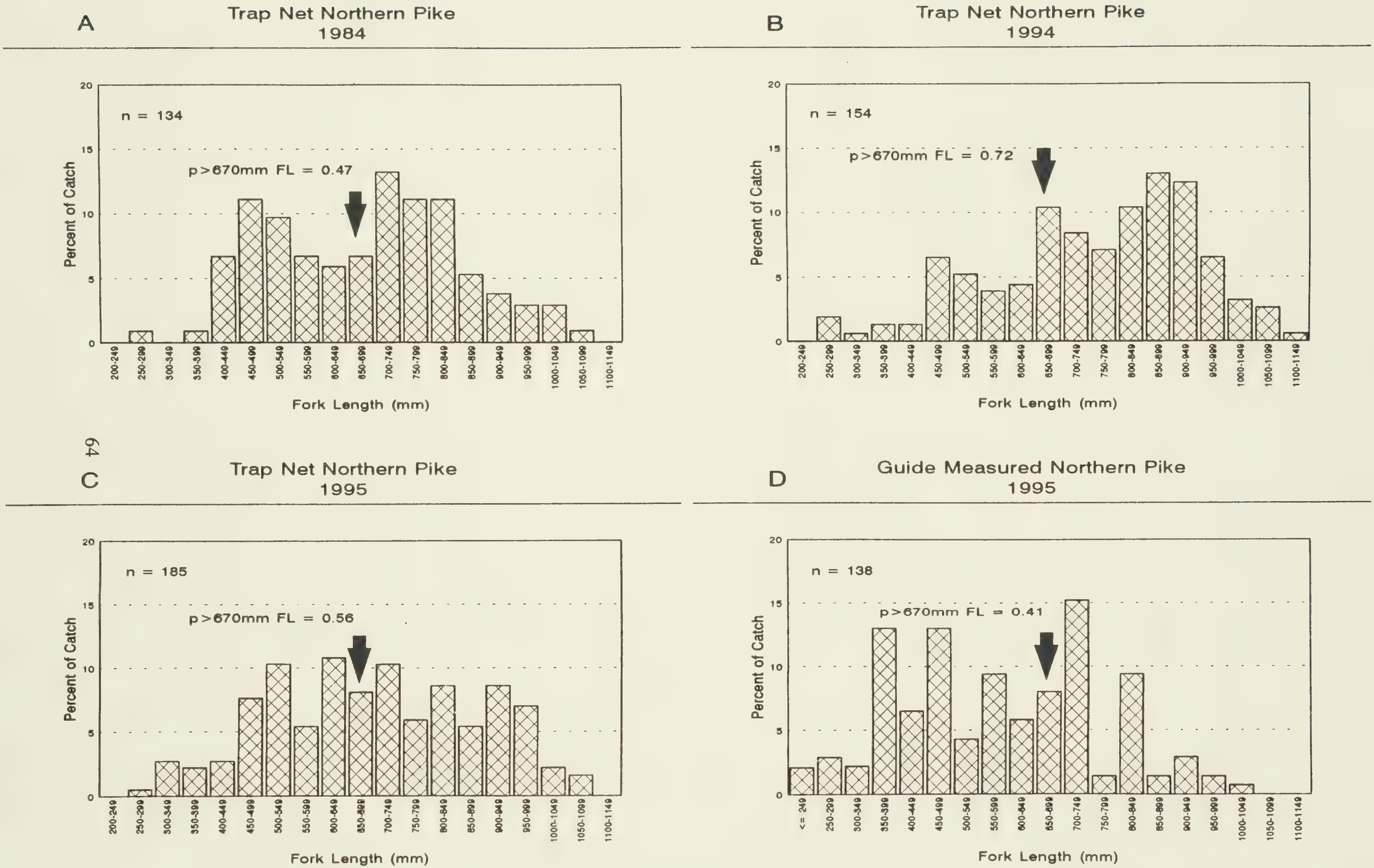


Fig. 13. Fork length (FL) frequency distributions by percent of catch, for trap netted and guide measured northern pike for Kesagami Lake 1984 to 1995.

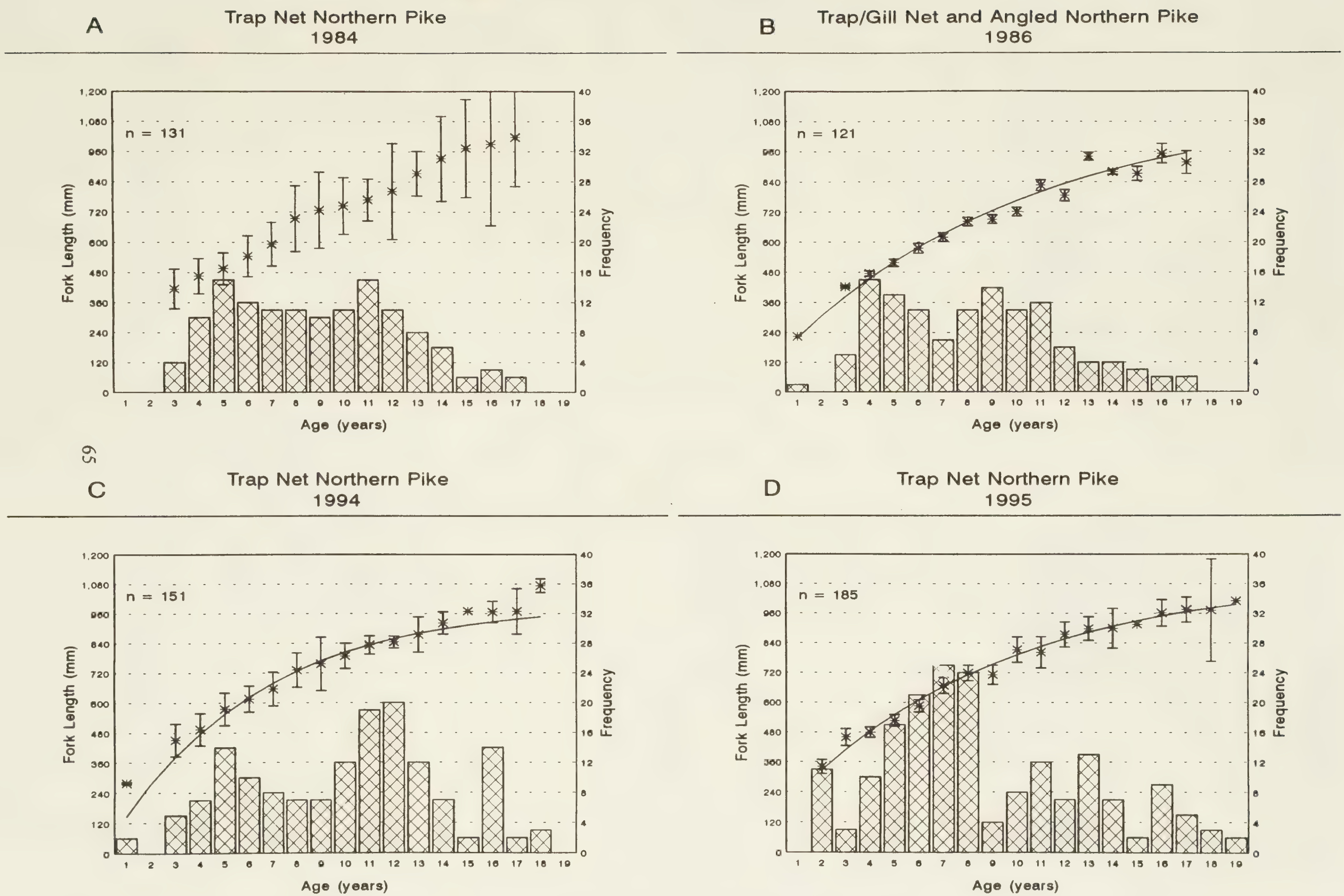


Fig. 14. Age distribution and growth curve for trap netted northern pike for 1984, 1986, 1994 and 1995

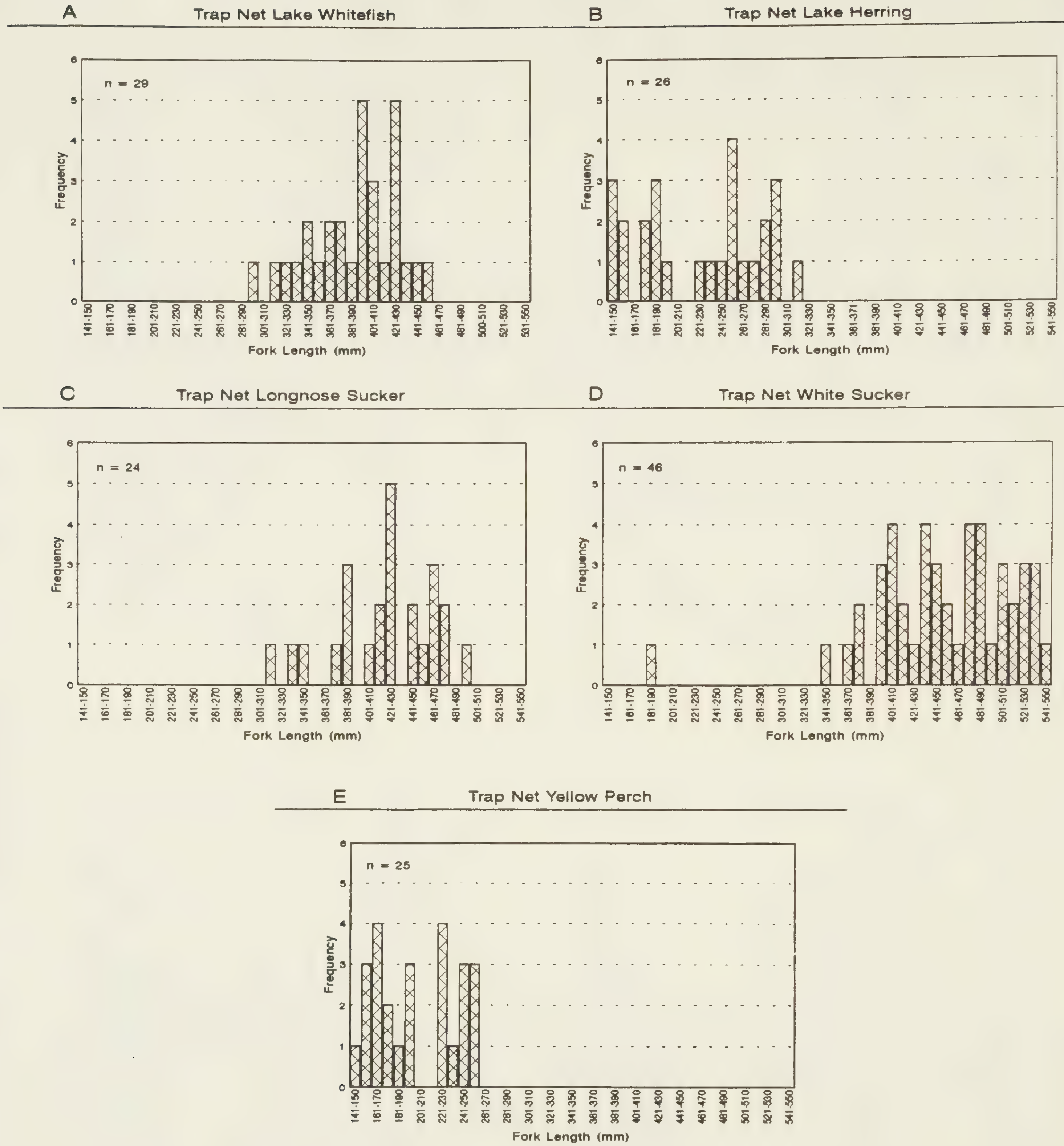


Fig. 15. Fork length distributions for associated nearshore fish species from trap net studies 1995.

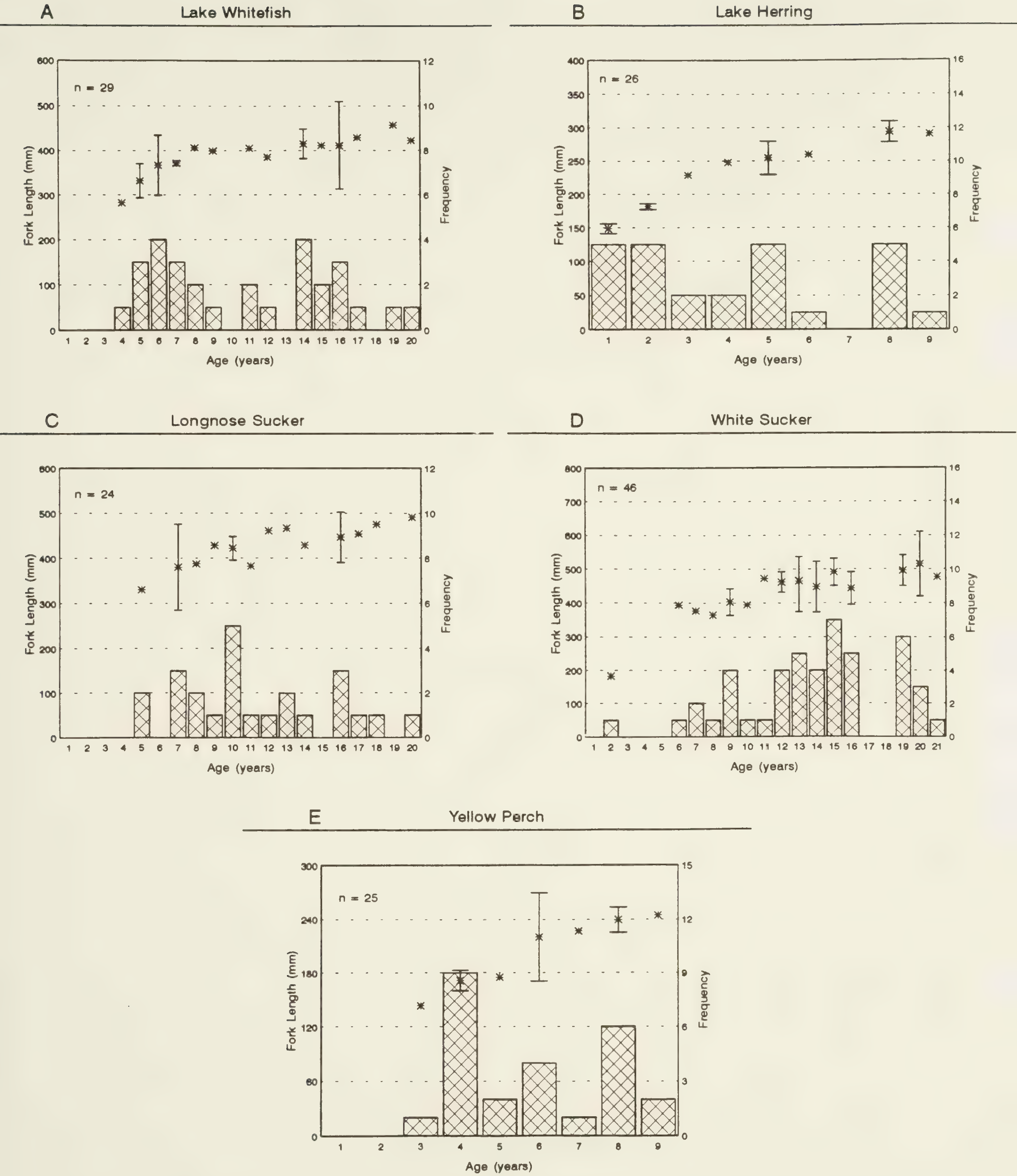


Fig. 16. Age distribution and growth for associated nearshore fish species from trap net studies 1995.

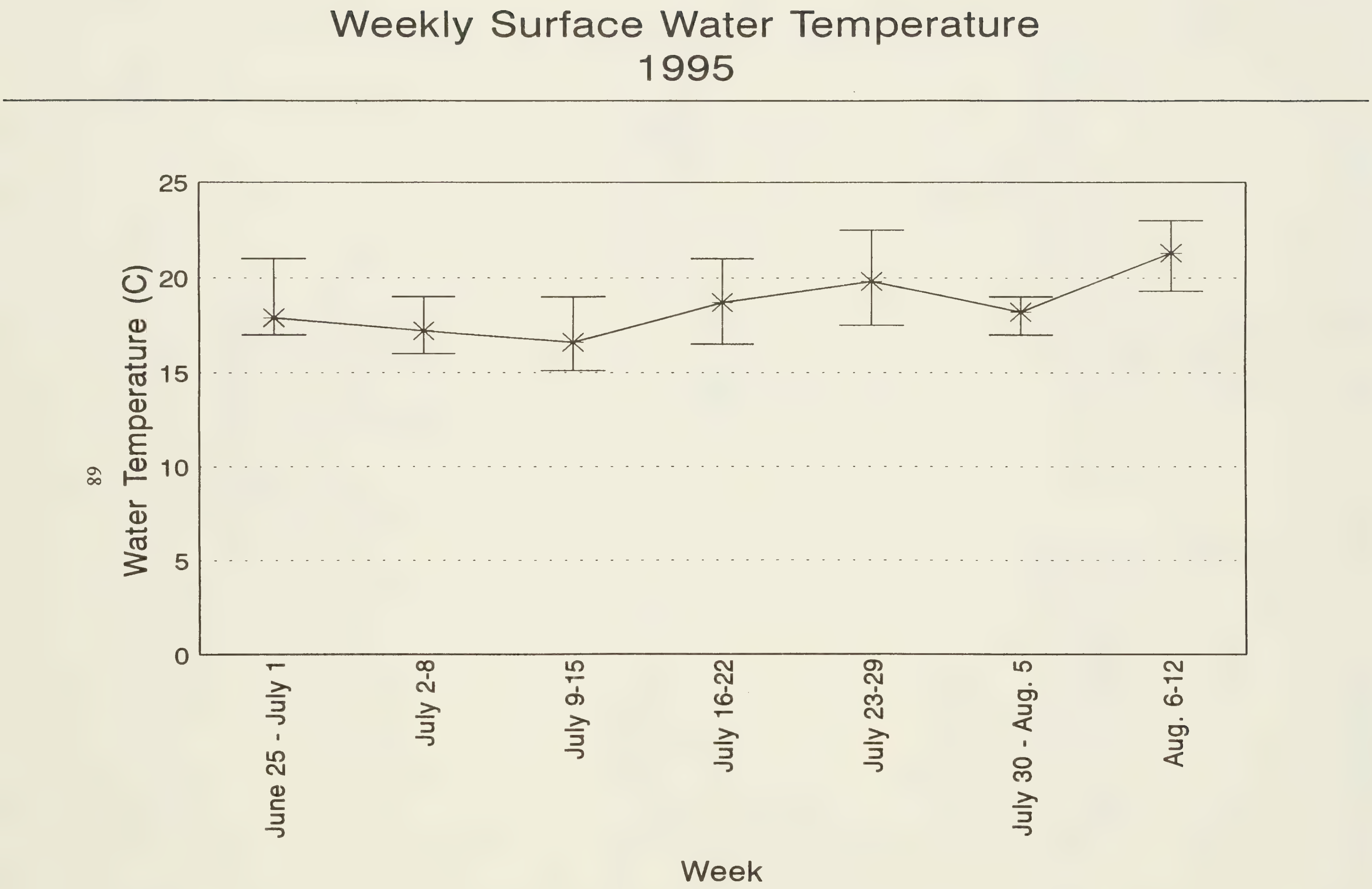


Fig. 17. Average minimum and maximum weekly surface water temperature recorded at 12 stations, Kesagami Lake 1995.

APPENDICIES

Appendix 1. Physical and chemical characteristics of Kesagami Lake based on aquatic habitat information summaries, 1984 and 1994.

PHYSICAL CHARACTERISTICS

Maximum depth	8.0 m
Mean depth	2.3 m (range 1.1 m to 8.0 m)
Estimated water fluctuation	0.87 m
Perimeter	193.2 km
Island shoreline 15.0 km	
Surface area	17,120.0 ha
Volume	38,668.8x10^4 m^3
Shoreline development factor	4.2

WATER CHEMISTRY

Secchi disc reading	1.1 to 1.7 m
Water colour	yellow/brown to blue/green
Thermocline	not present
Temperature range	10°C to 15.5°C
Lowest oxygen recorded	7.0 mg/L at 1 m in 1994 and 9.0 mg/L at 5.5 m
pH	7.5 to 8.0 (neutral)
Alkalinity	34.2 mg/L in 1995 with wider range recorded in 1984 (20.5 to 30.8 mg/L to 35.4 to 74.7 mg/L)
TDS	45 to 70.9 normal for precambrian waters
MEI	5.6 to 8.9

Note: No major water chemistry changes since 1984 as recorded in 1994.

Appendix 2. *CREESYS fisheries information system creel log form (Lester and Trippel 1985).*

951 (84/03)

Creel Log Form

Ministry of Natural Resources

Ontario

Project Code

Sample Area Code	Sample Start Time	Fishing Mode Code	Sample Date Year	Month	Day	Day Code	Weather Code

Count Start Time	Count Stop Time	Activity Count	Check Count	Interview Count

(FRONT)

Codes

Day
(1) Sunday
(2) Monday
(3) Tuesday
(4) Wednesday
(5) Thursday
(6) Friday
(7) Saturday

Weather
(0) no obvious adverse effect on fishing activity
(1) possible adverse effect on fishing activity
(2) adverse effect on fishing activity

Observer Name____________________

Appendix 3. Modified CREESYS fisheries information system creel interview form (Lester and Trippel 1985).

948 (84/03)

Creel Interview Form

Ontario — Ministry of Natural Resources

Project Code

Sample Area Code | Sample Start Time | Fishing Mode Code | Sample Date Year Month Day | Day Code

Interview Sequence Code | Interview Start Time | Fishing Start Time | Trip Complete Code (0 - no, 1 - yes) | Fishing Stop Time | Person Count | Angler Count | Rod Count

Fishing Method Code: 1 - still; 2 - jig; 3 - drift; 4 - troll; 5 - down rig; 6 - spin cast; 7 - fly cast; 8 - other or combination

Guide Code: 0 - no; 1 - yes

Origin Code: 1 - local; 2 - Ontario; 3 - Canada; 4 - U.S.; 5 - other

Visitor Code: 1 - permanent resident; 2 - non permanent resident; 3 - day tripper; 4 - camper - provincial park; 5 - camper - commercial park; 6 - camper - crown land; 7 - other paid; 8 - other non-paid

Option 1 Code: user defined (0-9) valid range

Option 2 Code

Option 3

Species Code | Sought Code (0 - no, 1 - yes) | Harvest Count | Release Count | Measured Count | Measured Weight (kilograms) | Catch records continued on the back of this form? (0 - no, 1 - yes)

Species Code	Sought Code (0 - no, 1 - yes)	Harvest Count	Release Count	Measured Count	Measured Weight (kilograms)

Option # 1 With which outfitter is your party accomodated?
1= Kesagami Lodge
2= Lindbergh's Hunting and Fishing Ltd.
3= Konopelky Air Service
4= Other ______________.

Option # 2 How many years have you fished Kesagami Lake?
(ask each individual)

Option #3 How has the quality of the angling in Kesagami Lake changed?
(ask each individual)

1= decreased
2= same
3= increased
4= no comment

#1(a) Did you have a shore lunch today? Y / N

(b) How many fish did you consume today? # Walleye ____ # N. Pike ____

#2 In which sectors of Kesagami Lake did you fish today? (see map for co-ordinates, ie. 14G, 22R, 08A) sectors: ____ ____ ____

#3 Are you aware of the current Ontario fishing regulations for Kesagami Lake? Y / N

#4 Do you think the regulations are effective at maintaining the quality of the fishery for: Walleye Y / N; N. Pike Y / N

#5 Would you support further fishing restrictions on Kesagami Lake? Y / N

#6 Does your outfitter have a camp fishing policy? Y / N

Appendix 4. Effort and catch form used in trap net assessment surveys on Kesagami Lake 1994 (Fulford 1993).

FORM 1: EFFORT AND CATCH FORM

DATE:____________ CREW:____________ SAM:______ DATA ENTRY USE

SITE:____________

GEAR DETAILS

NET TYPE:______ NET #:______ LENGTH OF LEADER USED :______m OR ______ft (XLEADUSE)

DEPTH OF WATER ALONG LEADER

@GAP END(m):______ (GRDEPMAX) @MID LEADER (m):______ (XGRDEPMID) @SHORE END(m):______ (GRDEPMIN)

LEAD-SHORE DISTANCE:______m OR ______ft (XDISTOFF) LEADER ANGLE:______ (XANGLE)

EFFORT DETAILS

SET DATE(EFFDT0):______ SET TIME(EFFTM0):______am/pm (12 hour clock, circle am or pm)

LIFT DATE(EFFDT1):______ LIFT TIME(EFFTM1):______am/pm

DURATION(hrs)(EFFDUR):______ STATUS(EFFST):______

SUBSTRATE AND COVER GENERAL SUBSTRATE CODE :______ GENERAL COVER CODE :______

SUBSTRATE DETAILS (%)

BEDROCK:______% BOULDER:______% RUBBLE/COBBLE:______% GRAVEL/PEBBLE:______%

SAND:______% SILT:______% CLAY:______% MUCK:______% DETRITUS:______%

(TOTAL SHOULD = 100)

COVER DETAILS (%)

BOULDER:______% LOG/TREE:______% ORGANIC DEBRIS:______% MACRO:______% COMBO:______%

NO COVER:______%

(TOTAL SHOULD = 100)

WEATHER DETAILS

AIR TEMP (C):______ WATER TEMP @ 0.3m(C):______ WAVEHT:______

CLOUD:______ PRECIP.:______ WIND SPEED (KNOTS):______

WIND DIRECTION:______

	# COUNTED ONLY		# LENGTH TALLIED				TOTAL
SPECIES	TALLY	A TOTAL	INITIAL CAPTURE	1st RECAP	2nd RECAP	B TOTAL LENGTH TALLY	(A+B) TOTAL CATCH (CATCNT)

ADDITIONAL COMMENTS:(set condition, etc)____________________

Appendix 5. Calculation of angling effort from Kesagami Lake Lodge post-season guest total and pooled creel survey estimate, Kesagami Lake 1995.

Calculation of effort from Kesagami Lake Lodge visitor statistics (C. MacDonald pers. comm.):

A.	Average number for guests in camp/day:	43
B.	Length of operating season (days):	86
C.	Proportion of guests angling:	0.8
D.	Angler-hrs/day (access creel)	7.7
E.	Proportion of all anglers accommodated at Kesagami Lodge (roving creel):	0.871
F.	Estimated total angling effort	26150 [(43 x 86 x 0.8) (7.7/0.871)]

Notes:

C. Proportion of guests angling accounts for anglers who did not fish every day, disruptions due to weather, and anglers at other camps who didn't fish Kesagami all the time.

D. The estimate of the number of angler-hrs/day from the access creel was used because interviews were usually done for complete trips at the end of the day.

E. The roving creel sampled anglers from all camps, whereas the access creel sampled Lodge guests almost exclusively.

Pooled estimate of effort from roving (R) and access (A) creels:

1. Access creel effort (16,999 angler-hr) x % Lodge guests (0.98) = 16,659 angler-hr for Lodge guests (A).

2. Roving creel effort (27,308 angler-hr) x % Lodge guests (0.87) = 23,758 angler-hr for Lodge guests (R).

3. Relation of A effort/R effort = 16,659/23,758 = 0.70

4. Estimate of non-Lodge effort missed by roving creel = Roving total - Roving Lodge = 27,308 angler-hr - 23,785 angler-hr = 3,523 angler-hr which is the Roving non-Lodge effort.

5. Convert roving to access non-Lodge effort as follows:
   Roving non-Lodge effort (3,523 angler-hr) x Access/Roving correction (0.70) + Access Lodge effort (16,659 angler-hr) = 19,125 angler-hr.

6. Therefore the pooled estimate = 19,125 angler-hr.

Appendix 6. Trap net set physical data, Kesagami Lake 1995.

Set	Date (set)	Substrate[a]	Cover[b] (%)	Air Temp.	H_2O Temp.	D.O. (mg/l)	Wave Ht. (cm)	Cloud (%)	Precip	Wind (spd/dir)
Spring Trap Net Data										
TN01	95-05-28	R40, SA40, C5, M5, D10	L10, N90	14.0	11.8	10.0	20	100	light	05/135
TN02	95-05-29	B10, R45, G35, SA10	N100	19.0	9.5	11.0	0	10		00/000
TN03	95-05-30	B40, R20, G5, SA5, C10, M10, D10	B10, L5, N85	13.0	11.5	11.0	25	95		10/135
TN04	95-05-30	B20, R5, SA10, SI5, C25, M25, D10	B20, L5, N75	14.0	11.9	10.5	5	0		00/000
TN05	95-05-31	B15, R15, G10, SA60	B5, N95	25.0	10.0	11.2	10	0		10/225
TN06	95-05-31	B5, R10, SA85	N100	18.0	16.0	9.4	20	95		10/180
TN07	95-06-01	SA60, M30, D10	D5, N95	12.0	11.5			50		20/315
TN08	95-06-01	SA40, M60	N100	6.0	12.0	8.5	5	100		05/000
TN09	95-06-02	SA90, C10	L5, N95	13.5	11.3	8.5	10	100	light	05/045
TN10	95-06-03	B20, R20, SA60	B10, N90	8.0	11.0	9.3	10	0		10/000
TN11	95-06-04	B10, SA20, C70	B5, L5, N90	12.0	12.0	9.0	10	100	light	02/315
TN12	95-06-04	B40, R40, G20	B5, N95	11.0	11.0	9.7	5	100	light	05/315
Summer Trap Net Data										
TN35	95-07-14	B10, R10, SA80	B1, V2, N97	15.0	21.0		25	100		10/315
TN22	95-07-14	B5, R5, G5, SA5, SI10, M50	B2, L3, N95	15.0	21.5		20	100		10/315
TN47	95-07-15	B5, SA5, C50, M30, D10	L5, V1, N94	13.0	19.0		0.1	10		05/315
TN21	95-07-15	SA20, C50, M20, D10	L5, V20, N75	17.0	19.0		30	0		10/315
TN34	95-07-16	B20, G10, SA50	B3, V2, N95	18.0	18.0		15	80		05/225
TN33	95-07-16	B5, SA20, SI5, C50, D20	L5, V40, N55	18.0	18.5		10	70		05/225
TN24	95-07-17	B20, R10, SA70	V5, N95	18.0	19.0		0	80		00/000
TN20	95-07-17	B10, SA90	B1, N99	20.0	21.0		10	100		05/045
TN37	95-07-18	B10, SA50, C30, D10	V5, N95	16.0	18.5		10	100	light	05/315
TN46	95-07-18	B10, R10, G5, SA70, SI5	V2, N98	18.0	19.0		0.5	10		15/315
TN23	95-07-19	B90, R10	B3, V2, N95	14.0	17.0		2	60		01/045

Set	Date (set)	Substrate[a]	Cover[b] (%)	Air Temp.	H_2O Temp.	D.O. (mg/l)	Wave Ht. (cm)	Cloud (%)	Precip	Wind (spd/dir)
TN45	95-07-21	B5, SA90	N100	16.0	19.0		0	80		25/315
TN31	95-07-22	B20, SA80	V2, N98	22.0	17.0		30	90	heavy	30/315
TN25	95-07-23	B50, SA50	V2, N98	27.0	24.0		2	5		02/135
TN39	95-07-24	B40, SA60	V5, N95	28.0	24.0		25	40		25/225
TN13	95-07-26	B90, SA10	V10, N90	28.0	24.0		4	30		05/270
TN36	95-07-27	B65, SA35	B5, N95	26.0	23.0		10	5		05/000
TN38	95-07-27	B80, SA20	B10, N90	25.0	23.0		5	5		00/000
TN18	95-07-28	B50, R10, SA40	B5, V5, N90	25.0	21.5		60	90		17/225
TN26	95-07-29	BD30, R10, SA60	B5, V2, N93	19.0	19.5		15	0		10/225
TN42	95-07-29	B20, R20, SA60	V10, N90	21.0	20.0		0.05	0		05/225
TN27	95-07-30	SA90, C10	V1, N99	15.0	18.5		2	0		05/225
TN32	95-07-30	B10, SA90	V5, N95	25.0	20.0		5	80		05/225
TN17	95-07-31	B80, R20	B5, N95	24.0	20.0		60	20		15/180
TN19	95-07-31	B10, SA80, C10	B5, N95	27.0	21.5		10	90		05/225
TN28	95-08-01	B30, R30, G30, SA10	B5, N95	10.0	19.0		40	100		07/045
TN29	95-08-01	B40, R30, G30	B5, N95	17.0	20.0		0	20		00/000
TN43	95-08-03	B5, SA95	V1, N99	23.0	20.0		0.1	0		10/135
TN16	95-08-04	B50, R30, SA20	B5, V5, N90	19.0	19.5		5	5		03/045
TN30	95-08-05	B5, R5, SA90	N100	18.0	18.5		10	10		07/180
TN14	95-08-06	R15, G20, SA65	N100	20.0	19.5		0	0		00/000
TN44	95-08-07	B15, R15, SA60, C10	B2, N98	18.0	20.0		0.4	10		09/135
TN15	95-08-08	B10, R10, G10, SA60, M10	N100	21.0	21.0		5	80		02/135

[a]Substrate codes used are as follows; rock (BD), boulder (B), rubble (R), gravel (G), sand (SA), silt (SI), clay (C), muck (M), detritus (D).
[b]Cover codes used are as follows; boulder (B), logs and trees (L), vegetation (V) and none (N).

Appendix 7. Trap net catch summary, Kesagami Lake 1986.

Species		Lake Whitefish 91	Lake Herring 93	Northern Pike 131	Longnose Sucker 162	White Sucker 163	Burbot 271	Yellow Perch 331	Walleye 334
All	sum	151	185	110	27	270	2	172	623
	count	36	36	36	36	36	36	36	36
	mean	4.19	5.14	3.06	0.75	7.50	0.06	4.78	17.31
	S.D.	5.38	6.23	2.62	1.27	5.30	0.23	14.54	20.40
	LCL	2.44	3.11	2.20	0.33	5.77	-0.02	0.03	10.64
	UCL	5.95	7.17	3.91	1.17	9.23	0.13	9.53	23.97
Spring June 19-28	sum	116	181	68	21	161	0	25	338
	count	25	25	25	25	25	25	25	25
	mean	4.64	7.24	2.72	0.84	6.44	0.00	1.00	13.52
	S.D.	4.64	6.42	2.32	1.31	5.64	0.00	1.50	9.04
	LCL	2.82	4.72	1.81	0.33	4.23	0.00	0.41	9.98
	UCL	6.46	9.76	3.63	1.35	8.65	0.00	1.59	17.06
Summer July 16-23	sum	35	4	42	6	109	2	147	285
	count	11	11	11	11	11	11	11	11
	mean	3.18	0.36	3.82	0.55	9.91	0.18	13.36	25.91
	S.D.	6.93	0.67	3.19	1.21	3.59	0.40	24.85	33.80
	LCL	-0.91	-0.03	1.93	-0.17	7.79	-0.06	-1.32	5.93
	UCL	7.27	0.76	5.70	1.26	12.03	0.42	28.05	45.89

Appendix 8. Fork length frequency distributions of angled (AN) and trap net (TN) caught walleye for Kesagami Lake 1984 to 1995.

FL (Min)	FL (max)	1984		1994				1995			
		TN (spring)	AN	TN		AN		TN		AN	
		%	%	No.	%	No.	%	No.	%	No.	%
160	189										
190	219							11	4.1		
220	249							9	3.4		
250	279			5	2.1	1	1.0	9	3.4	1	0.4
280	309	1.6	0.8	10	4.2	4	3.8	22	8.3	4	1.6
310	339	14.0	6.1	22	9.2	6	5.8	46	17.3	26	10.6
340	369	31.0	25.7	42	17.5	21	20.2	58	21.8	57	23.3
370	399	38.0	37.1	77	32.1	37	35.6	54	20.3	64	26.1
400	429	12.4	17.4	39	16.3	20	19.2	27	10.2	54	22.0
430	459	1.6	6.8	30	12.5	12	11.5	15	5.6	31	12.7
460	489	0.8	4.5	9	3.8	2	1.9	10	3.8	6	2.4
490	519		0.8	1	0.4	1	1.0	2	0.8	1	0.4
520	549		0.8	1	0.4						
550	579	0.8		2	0.8			1	0.4	1	0.4
580	609			1	0.4			1	0.4		
610	639										
640	669			1	0.4			1	0.4		
Total (No. of fish)		512	209	240		104		266		245	

Note - 1984 percent frequencies were derived from histograms. Number of fish in each class were not available and percent frequencies may be imprecise.

Appendix 9. Mean fork length[a] at age for Kesagami Lake walleye in 1984 and 1986.

Age frequency distribution and mean fork length at age for walleye, Kesagami Lake 1984.

Age	f(AN)	f(TN)	FL	LCL	UCL
1					
2					
3					
4	2	2	277.5	134.6	420.4
5	1	3	323.7	313.5	333.9
6	2	14	320.5	296.0	345.0
7	11	17	340.4	303.7	377.1
8	29	36	354.8	319.9	389.7
9	31	45	371.4	346.9	395.9
10	44	26	382.2	361.2	403.2
11	22	29	395.9	341.8	450.0
12	26	17	410.1	385.0	435.2
13	11	3	412.3	371.9	452.7
14	13	2	442.0	308.2	575.8
15	6	1	448.0		
16	6				
17	3				
18					
19					
20					
Total	207	195			

Note: Mean lengths were available for trap net data only.

Age frequency and mean fork length at age for walleye Kesagami Lake 1986.

Age	f(TN)	f(AN)	f(all)	FL	LCL	UCL
1						
2						
3	6		6	224.3	181.2	267.4
4	18		18	277.2	236.7	317.7
5	52		52	291.1	258.1	324.1
6	42	1	43	312.8	268.6	357.0
7	29	3	32	329.5	281.4	377.6
8	40	6	46	352.8	304.8	400.8
9	61	18	79	365.5	326.3	404.7
10	73	65	138	374.8	326.6	423.0
11	55	45	100	390.2	335.6	444.8
12	38	41	79	399.1	341.6	456.6
13	15	20	35	411.6	353.3	469.9
14	4	5	9	451.2	396.9	505.5
15	7	5	12	446.7	387.2	506.2
16	1	1	2	500	256.5	743.5
17	2		2	463	329.2	596.8
18						
19						
20	1		1	639		
Total	444	210	654			

Note: Mean lengths are based on trap net and angling data combined.

[a]Mean fork lengths were available for trap net data only in 1984 (Armstrong 1984) and for trap net and angled data combined in 1986 (Hendry and Payne 1986).

Appendix 10. Basic fish attributes collected for trap net captured walleye, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
2	TL	4	214.0	213.6	218.5	223.5	221.0	3.11
	FL	4	200.0	199.7	204.0	208.3	206.0	2.71
	RWT	4	70.0	70.0	70.0	70.0	70.0	0.00
4	TL	9	225.0	229.6	235.2	240.9	248.0	7.36
	FL	9	209.0	213.9	219.8	225.7	232.0	7.71
	RWT	9	90.0	98.8	105.6	112.3	120.0	8.82
5	TL	21	234.0	266.3	279.1	291.8	325.0	27.94
	FL	21	217.0	247.5	259.6	271.8	304.0	26.68
	RWT	21	100.0	152.3	176.2	200.0	290.0	52.39
6	TL	20	300.0	323.3	331.5	339.7	359.0	17.55
	FL	20	280.0	301.8	309.9	317.9	338.0	17.16
	RWT	20	200.0	283.1	307.0	330.9	400.0	51.00
7	TL	19	300.0	330.8	339.5	348.3	375.0	18.12
	FL	19	279.0	308.4	316.8	325.2	353.0	17.51
	RWT	19	230.0	314.1	339.5	364.9	440.0	52.65
8	TL	50	320.0	368.0	373.8	379.6	438.0	20.46
	FL	50	303.0	343.0	348.5	353.9	406.0	19.21
	RWT	50	260.0	425.9	449.4	472.9	740.0	82.65
9	TL	14	328.0	351.0	362.9	374.9	391.0	20.69
	FL	14	304.0	327.4	339.2	351.0	365.0	20.48
	RWT	14	310.0	374.2	412.1	450.1	530.0	65.65
10	TL	7	359.0	374.4	388.0	401.6	406.0	14.75
	FL	7	334.0	348.0	361.1	374.3	380.0	14.27
	RWT	7	410.0	445.5	485.7	526.0	550.0	43.53
11	TL	4	357.0	351.2	377.3	403.3	392.0	16.38
	FL	4	332.0	325.4	349.8	374.1	363.0	15.28
	RWT	4	380.0	357.0	437.5	518.0	500.0	50.58
12	TL	14	363.0	395.7	415.7	435.8	513.0	34.75
	FL	14	339.0	369.4	388.7	408.0	483.0	33.41
	RWT	14	400.0	486.2	587.1	688.1	1100.0	174.82
13	TL	9	385.0	394.5	422.0	449.5	493.0	35.80
	FL	9	362.0	370.6	396.0	421.4	463.0	33.08
	RWT	9	500.0	498.3	623.3	748.4	1000.0	162.63
14	TL	19	381.0	408.2	428.0	447.8	507.0	41.16
	FL	19	353.0	380.2	400.5	420.8	485.0	42.11
	RWT	19	410.0	547.6	679.5	811.4	1250.0	273.65
15	TL	9	378.0	401.8	431.4	461.1	476.0	38.60
	FL	9	350.0	373.4	402.4	431.5	450.0	37.77
	RWT	9	490.0	515.3	655.6	795.8	1010.0	182.42
16	TL	9	398.0	418.8	470.0	521.2	619.0	66.83

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
	FL	9	373.0	390.5	439.1	487.8	583.0	63.31
	RWT	9	500.0	527.6	952.8	1378.0	2325.0	533.16
17	TL	3	381.0	330.4	417.7	504.9	451.0	35.12
	FL	3	356.0	311.5	389.0	466.5	418.0	31.19
	RWT	3	440.0	220.4	593.3	966.2	740.0	150.11
18	TL	1	409.0		409.0		409.0	
	FL	1	380.0		380.0		380.0	
	RWT	1	450.0		450.0		450.0	
19	TL	3	389.0	357.0	399.3	441.7	419.0	17.04
	FL	3	362.0	336.3	71.7	407.0	388.0	14.22
	RWT	3	490.0	378.9	530.0	681.1	600.0	60.83
20	TL	9	396.0	399.2	410.4	421.7	445.0	14.66
	FL	9	369.0	370.5	381.9	393.3	419.0	14.81
	RWT	9	420.0	496.9	553.3	609.8	680.0	73.49
21	TL	8	411.0	415.1	427.0	438.9	457.0	14.18
	FL	8	380.0	385.9	398.4	410.9	430.0	14.93
	RWT	8	580.0	581.9	662.5	743.2	880.0	96.47
22	TL	14	401.0	429.4	454.9	480.3	545.0	44.04
	FL	14	375.0	400.8	426.5	452.3	518.0	44.60
	RWT	14	500.0	615.3	791.4	967.6	1550.0	305.03
23	TL	4	431.0	428.8	453.3	477.7	466.0	15.39
	FL	4	402.0	398.7	425.0	451.3	440.0	16.51
	RWT	4	620.0	596.2	707.5	818.8	790.0	69.94
24	TL	7	408.0	413.6	474.3	534.9	602.0	65.58
	FL	7	384.0	388.3	445.9	503.4	570.0	62.27
	RWT	7	530.0	409.7	925.7	1441.8	2150.0	558.00
25	TL	3	421.0	383.3	450.0	516.7	474.0	26.85
	FL	3	394.0	359.8	420.0	480.2	442.0	24.25
	RWT	3	590.0	444.5	693.3	942.2	790.0	100.17
26	TL	4	434.0	414.2	460.8	507.3	495.0	29.24
	FL	4	398.0	381.0	429.8	478.5	466.0	30.62
	RWT	4	530.0	372.1	730.0	1087.9	1000.0	224.94
32	TL	2	441.0		567.5		694.0	178.90
	FL	2	410.0		531.5		**653.0**	171.83
	RWT	2	640.0		1970.0		**3300.0**	1880.90

Total	TL	266	214.0	373.4	381.9	390.4	694.0	70.69
	FL	266	200.0	348.6	**356.7**	364.7	653.0	66.92
	RWT	266	70.0	470.0	**509.6**	549.2	3300.0	327.74
	Age	266	2.0	11.1	11.9	12.6	32.0	6.42

Appendix 11. Basic fish attributes collected for angled walleye, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
6	TL	7	318.0	334.0	357.3	380.6	387.0	25.24
	FL	7	297.0	313.1	335.0	356.9	362.0	23.71
	RWT	7	270.0	320.0	384.3	448.6	460.0	69.49
7	TL	10	305.0	320.1	355.6	391.1	482.0	49.67
	FL	10	285.0	299.1	333.1	367.1	455.0	47.58
	RWT	10	230.0	260.8	411.0	561.2	970.0	209.94
8	TL	45	285.0	364.8	371.4	377.9	405.0	21.75
	FL	45	258.0	339.6	345.9	352.2	380.0	21.01
	RWT	45	180.0	419.7	444.0	468.3	600.0	80.97
9	TL	11	325.0	359.4	372.8	386.2	394.0	19.94
	FL	11	303.0	335.8	348.5	361.1	369.0	18.84
	RWT	11	280.0	405.2	459.1	513.0	560.0	80.18
10	TL	4	373.0	368.6	393.5	418.4	411.0	15.63
	FL	4	350.0	343.9	367.8	391.6	386.0	14.98
	RWT	4	460.0	414.9	517.5	620.1	610.0	64.49
11	TL	2	361.0		417.5		474.0	79.90
	FL	2	334.0		389.5		445.0	78.49
	RWT	2	400.0		620.0		840.0	311.13
12	TL	32	368.0	407.2	416.1	424.9	464.0	24.59
	FL	32	345.0	379.1	387.7	396.2	435.0	23.66
	RWT	32	430.0	571.6	611.9	652.1	840.0	111.63
13	TL	2	372.0		406.0		440.0	48.08
	FL	2	347.0		378.0		409.0	43.84
	RWT	2	480.0		565.0		650.0	120.21
14	TL	32	385.0	423.5	434.6	445.8	498.0	30.88
	FL	32	357.0	395.5	405.9	416.4	465.0	28.90
	RWT	32	510.0	638.4	690.6	742.8	1040.0	144.78
15	TL	18	390.0	417.3	431.8	446.2	488.0	29.03
	FL	18	364.0	391.2	404.2	417.3	454.0	26.25
	RWT	18	480.0	605.5	685.6	765.6	1100.0	160.92
16	TL	16	416.0	437.1	449.1	461.0	491.0	22.46
	FL	16	387.0	407.6	419.6	431.7	464.0	22.64
	RWT	16	580.0	697.0	758.1	819.2	950.0	114.67
17	TL	7	380.0	388.7	412.7	436.7	452.0	25.93
	FL	7	351.0	363.1	386.0	408.9	420.0	24.81
	RWT	7	470.0	487.2	587.1	687.1	770.0	108.12
18	TL	2	415.0		415.0		415.0	0.00
	FL	2	385.0		387.5		390.0	3.54

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
	RWT	2	460.0		505.0		550.0	63.64
19	TL	4	385.0	369.2	422.3	475.4	464.0	33.37
	FL	4	356.0	341.5	391.3	441.0	430.0	31.26
	RWT	4	430.0	335.4	587.5	839.6	790.0	158.40
20	TL	14	395.0	415.8	432.9	450.1	513.0	29.69
	FL	14	370.0	387.6	404.0	420.4	481.0	28.40
	RWT	14	500.0	583.3	676.4	769.6	1100.0	161.37
21	TL	7	392.0	393.8	428.0	462.2	485.0	37.02
	FL	7	366.0	367.1	399.1	431.2	449.0	34.63
	RWT	7	490.0	456.1	631.4	806.8	1000.0	189.60
22	TL	9	380.0	413.5	430.7	447.9	465.0	22.36
	FL	9	358.0	388.2	404.3	420.5	439.0	21.03
	RWT	9	450.0	581.1	674.4	767.8	900.0	121.4[illegible]
23	TL	3	486.0	446.8	510.3	573.9	537.0	25.58
	FL	3	457.0	428.3	478.3	528.4	497.0	20.13
	RWT	3	770.0	464.5	1006.7	1548.8	1200.0	218.25
24	TL	7	400.0	397.5	454.9	512.3	582.0	62.07
	FL	7	373.0	369.4	428.3	487.2	**562.0**	63.72
	RWT	7	530.0	437.1	782.9	1128.6	**1600.0**	373.84
25	TL	7	415.0	440.0	467.6	495.2	505.0	29.84
	FL	7	387.0	411.0	437.1	463.3	470.0	28.30
	RWT	7	460.0	616.6	817.1	1017.1	1100.0	216.85
26	TL	4	409.0	371.0	456.5	542.0	520.0	53.73
	FL	4	378.0	342.8	424.8	506.7	485.0	51.49
	RWT	4	520.0	297.2	832.5	1367.8	1300.0	336.39
27	TL	1			452.0			
	FL	1			425.0			
	RWT	1			680.0			
30	TL	1			465.0			
	FL	1			434.0			
	RWT	1			720.0			

Total	TL	245	285.0	408.1	413.6	419.2	582.0	44.26
	FL	245	258.0	381.0	**386.3**	391.6	562.0	42.05
	RWT	245	180.0	582.9	**607.4**	631.8	1600.0	194.40
	Age	245	6.0	13.4	14.1	14.8	30.0	5.56

Appendix 12. Basic fish attributes collected for angled and trap net caught walleye, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
2	TL	4	214.0	213.6	218.5	223.5	221.0	3.11
	FL	4	200.0	199.7	204.0	208.3	206.0	2.71
	RWT	4	70.0	70.0	70.0	70.0	70.0	0.00
4	TL	9	225.0	229.6	235.2	240.9	248.0	7.36
	FL	9	209.0	213.9	219.8	225.7	232.0	7.71
	RWT	9	90.0	98.8	105.6	112.3	120.0	8.82
5	TL	21	234.0	266.3	279.1	291.8	325.0	27.94
	FL	21	217.0	247.5	259.6	271.8	304.0	26.68
	RWT	21	100.0	152.3	176.2	200.0	290.0	52.39
6	TL	27	300.0	329.3	338.2	347.1	387.0	22.46
	FL	27	280.0	307.8	316.4	325.0	362.0	21.70
	RWT	27	200.0	301.4	327.0	352.7	460.0	64.86
7	TL	29	300.0	332.7	345.1	357.5	482.0	32.63
	FL	29	279.0	310.5	322.4	334.4	455.0	31.42
	RWT	29	230.0	314.3	364.1	414.0	970.0	130.94
8	TL	95	285.0	368.4	372.6	376.9	438.0	21.00
	FL	95	258.0	343.2	347.3	351.3	406.0	20.02
	RWT	95	180.0	430.3	446.8	463.4	740.0	81.47
9	TL	25	325.0	358.8	367.3	375.8	394.0	20.56
	FL	25	303.0	335.1	343.3	351.5	369.0	19.93
	RWT	25	280.0	402.0	432.8	463.6	560.0	74.70
10	TL	11	359.0	380.2	390.0	399.8	411.0	14.55
	FL	11	334.0	354.0	363.6	373.1	386.0	14.16
	RWT	11	410.0	462.7	497.3	531.8	610.0	51.40
11	TL	6	357.0	345.3	390.7	436.1	474.0	43.24
	FL	6	332.0	318.6	363.0	407.4	445.0	42.35
	RWT	6	380.0	317.2	498.3	679.4	840.0	172.56
12	TL	46	363.0	407.7	416.0	424.2	513.0	27.66
	FL	46	339.0	380.1	388.0	395.9	483.0	26.62
	RWT	46	400.0	565.0	604.4	643.7	1100.0	132.46
13	TL	11	372.0	394.9	419.1	443.3	493.0	36.03
	FL	11	347.0	370.2	392.7	415.2	463.0	33.48
	RWT	11	480.0	510.5	612.7	715.0	1000.0	152.19
14	TL	51	381.0	422.4	432.2	442.0	507.0	34.81
	FL	51	353.0	394.3	403.9	413.5	485.0	34.11

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
	RWT	51	410.0	630.2	686.5	742.7	1250.0	199.96
15	TL	27	378.0	419.1	431.7	444.2	488.0	31.77
	FL	27	350.0	391.8	403.6	415.4	454.0	29.84
	RWT	27	480.0	610.1	675.6	741.0	1100.0	165.47
16	TL	25	398.0	438.6	456.6	474.6	619.0	43.59
	FL	25	373.0	409.4	426.6	443.9	583.0	41.80
	RWT	25	500.0	685.6	828.2	970.8	2325.0	345.41
17	TL	10	380.0	394.9	414.2	433.5	452.0	26.98
	FL	10	351.0	369.0	386.9	404.8	420.0	25.07
	RWT	10	440.0	508.0	589.0	670.0	770.0	113.18
18	TL	3	409.0	404.4	413.0	421.6	415.0	3.46
	FL	3	380.0	372.6	385.0	397.4	390.0	5.00
	RWT	3	450.0	349.9	486.7	623.5	550.0	55.08
19	TL	7	385.0	386.2	412.4	438.7	464.0	28.35
	FL	7	356.0	359.0	382.9	406.7	430.0	25.80
	RWT	7	430.0	450.6	562.9	675.1	790.0	121.34
20	TL	23	395.0	412.5	424.1	435.8	513.0	26.93
	FL	23	369.0	384.1	395.4	406.6	481.0	26.04
	RWT	23	420.0	565.4	628.3	691.1	1100.0	145.34
21	TL	15	392.0	412.9	427.5	442.0	485.0	26.23
	FL	15	366.0	384.9	398.7	412.6	449.0	25.01
	RWT	15	490.0	569.1	648.0	726.9	1000.0	142.54
22	TL	23	380.0	428.8	445.4	462.0	545.0	38.39
	FL	23	358.0	401.3	417.8	434.3	518.0	38.19
	RWT	23	450.0	636.5	745.7	854.8	1550.0	252.49
23	TL	7	431.0	444.8	477.7	510.6	537.0	35.60
	FL	7	402.0	417.4	447.9	478.3	497.0	32.93
	RWT	7	620.0	642.0	835.7	1029.5	1200.0	209.51
24	TL	14	400.0	428.7	464.6	500.5	602.0	62.17
	FL	14	373.0	401.7	437.1	472.4	570.0	61.21
	RWT	14	530.0	587.4	854.3	1121.2	2150.0	462.28
25	TL	10	415.0	441.7	462.3	482.9	505.0	28.74
	FL	10	387.0	412.6	432.0	451.4	470.0	27.08
	RWT	10	460.0	642.1	780.0	917.9	1100.0	192.76
26	TL	8	409.0	425.1	458.6	492.2	520.0	40.11
	FL	8	378.0	394.4	427.3	460.1	485.0	39.31

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
	RWT	8	520.0	555.1	781.3	1007.4	1300.0	270.53
27	TL	1			452.0			
	FL	1			425.0			
	RWT	1			680.0			
30	TL	1			465.0			
	FL	1			434.0			
	RWT	1			720.0			
32	TL	2	441.0		567.5		694.0	178.90
	FL	2	410.0		531.5		653.0	171.83
	RWT	2	640.0		1970.0		3300.0	1880.90

Total	TL	511	214.0	391.8	697.1	402.5	694.0	61.52
	FL	511	200.0	365.8	370.9	375.9	653.0	58.25
	RWT	511	70.0	532.5	556.5	580.5	3300.0	276.20
	Age	511	2.0	12.4	12.9	13.5	32.0	6.12

Appendix 13. Basic fish attributes collected for angled and trap net caught male walleye, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
2	TL	1			221.0			
	FL	1			206.0			
	RWT	1			70.0			
5	TL	1			285.0			
	FL	1			265.0			
	RWT	1			200.0			
6	TL	2	348.0		367.5		387.0	27.58
	FL	2	327.0		344.5		362.0	24.75
	RWT	2	340.0		400.0		460.0	84.85
7	TL	4	318.0	309.2	333.8	358.4	355.0	15.46
	FL	4	295.0	287.5	313.8	340.0	335.0	16.52
	RWT	4	280.0	241.3	325.0	408.7	400.0	52.60
8	TL	15	346.0	364.0	370.0	376.0	385.0	10.78
	FL	15	320.0	338.1	343.9	349.8	360.0	10.63
	RWT	15	340.0	400.8	420.0	439.2	460.0	34.64
9	TL	3	360.0	342.8	367.7	392.6	379.0	10.02
	FL	3	339.0	318.0	346.0	374.0	359.0	11.27
	RWT	3	410.0	366.0	423.3	480.7	450.0	23.09
11	TL	1			361.0			
	FL	1			334.0			
	RWT	1			400.0			
12	TL	7	389.0	391.7	405.1	418.6	434.0	14.53
	FL	7	360.0	361.5	375.6	389.7	405.0	15.24
	RWT	7	500.0	517.3	574.3	631.3	700.0	61.61
14	TL	11	385.0	395.2	403.1	411.0	422.0	11.81
	FL	11	357.0	368.8	376.5	384.1	395.0	11.44
	RWT	11	470.0	519.9	550.9	581.9	620.0	46.14
15	TL	5	400.0	389.6	418.4	447.2	457.0	23.18
	FL	5	375.0	364.1	391.0	417.9	427.0	21.65
	RWT	5	500.0	456.5	582.0	707.5	750.0	101.09
16	TL	3	416.0	400.3	428.0	455.7	438.0	11.14
	FL	3	389.0	377.3	399.0	420.7	405.0	8.72
	RWT	3	580.0	491.7	630.0	768.3	690.0	55.68
17	TL	3	390.0	325.8	412.0	498.2	452.0	34.70
	FL	3	366.0	309.6	385.0	460.4	420.0	30.35

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
	RWT	3	490.0	192.1	586.7	981.3	770.0	158.85
18	TL	2	409.0		412.0		415.0	4.24
	FL	2	380.0		382.5		385.0	3.54
	RWT	2	450.0		500.0		550.0	70.71
19	TL	1			385.0			
	FL	1			356.0			
	RWT	1			430.0			
20	TL	6	395.0	396.7	412.7	428.6	441.0	15.21
	FL	6	370.0	371.1	384.0	396.9	407.0	12.31
	RWT	6	500.0	483.9	566.7	649.5	710.0	78.91
22	TL	4	380.0	377.4	416.5	455.6	432.0	24.57
	FL	4	358.0	355.9	391.3	426.6	404.0	22.23
	RWT	4	450.0	435.2	610.0	784.8	700.0	109.85
23	TL	1			460.0			
	FL	1			433.0			
	RWT	1			790.0			
24	TL	1			435.0			
	FL	1			411.0			
	RWT	1			690.0			
25	TL	2	421.0		431.5		442.0	14.85
	FL	2	394.0		403.0		412.0	12.73
	RWT	2	590.0		595.0		600.0	7.07
26	TL	3	409.0	334.7	435.3	536.0	482.0	40.53
	FL	3	378.0	306.6	404.7	502.7	450.0	39.46
	RWT	3	520.0	291.6	676.7	1061.8	830.0	155.03
27	TL	1			452.0			
	FL	1			425.0			
	RWT	1			680.0			

Total	TL	77	221.0	385.1	394.0	403.0	482.0	39.43
	FL	77	206.0	359.2	367.6	376.0	450.0	37.00
	RWT	77	70.0	484.6	514.7	544.8	830.0	132.69
	Age	77	2.0	12.7	14.1	15.4	27.0	6.07

Appendix 14. Basic fish attributes collected for angled and trap net caught female walleye, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
4	TL	2	230.0		230.5		231.0	0.71
	FL	2	215.0		215.5		216.0	0.71
	RWT	2	100.0		105.0		110.0	7.07
5	TL	2	269.0		278.5		288.0	13.44
	FL	2	251.0		260.5		270.0	13.44
	RWT	2	160.0		180.0		200.0	28.28
6	TL	7	303.0	323.7	348.0	372.3	377.0	26.27
	FL	7	281.0	302.4	326.1	349.9	354.0	25.65
	RWT	7	230.0	299.3	365.7	432.2	430.0	71.85
7	TL	6	305.0	306.7	370.2	433.7	482.0	60.51
	FL	6	285.0	284.7	346.0	407.3	455.0	58.41
	RWT	6	230.0	195.0	468.3	741.6	970.0	260.42
8	TL	27	285.0	364.3	374.6	384.9	405.0	25.96
	FL	27	258.0	339.0	348.9	358.9	380.0	25.17
	RWT	27	180.0	423.6	461.9	500.1	600.0	96.60
9	TL	7	362.0	371.8	382.4	393.1	394.0	11.52
	FL	7	337.0	346.6	357.1	367.7	369.0	11.45
	RWT	7	410.0	444.0	494.3	544.6	560.0	54.42
10	TL	3	373.0	345.4	392.7	440.0	411.0	19.04
	FL	3	350.0	321.6	366.7	411.8	386.0	18.15
	RWT	3	460.0	330.4	523.3	716.3	610.0	77.68
11	TL	1			357.0			
	FL	1			332.0			
	RWT	1			380.0			
12	TL	15	381.0	410.3	423.6	436.9	464.0	24.02
	FL	15	355.0	383.0	395.7	408.5	435.0	22.97
	RWT	15	430.0	564.0	632.0	700.0	840.0	122.78
13	TL	2	372.0		406.0		440.0	48.08
	FL	2	347.0		378.0		409.0	43.84
	RWT	2	480.0		565.0		650.0	120.21
14	TL	16	415.0	441.0	452.3	463.5	487.0	21.13
	FL	16	386.0	412.1	422.7	433.3	455.0	19.87
	RWT	16	550.0	700.5	759.4	818.3	950.0	110.54
15	TL	8	390.0	406.3	432.8	459.2	480.0	31.61
	FL	8	375.0	382.5	405.9	429.3	450.0	27.98

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
	RWT	8	510.0	564.5	690.0	815.5	960.0	150.14
16	TL	12	432.0	444.7	459.3	473.8	501.0	22.94
	FL	12	401.00	415.0	429.7	444.4	468.0	23.16
	RWT	12	670.0	736.5	811.7	886.8	1100.0	118.31
17	TL	3	380.0	342.0	412.7	483.3	432.0	28.45
	FL	3	351.0	310.7	386.0	461.3	404.0	30.32
	RWT	3	470.0	338.3	583.3	828.4	650.0	98.66
19	TL	1			464.0			
	FL	1			430.0			
	RWT	1			790.0			
20	TL	6	420.0	412.6	447.5	482.4	513.0	33.27
	FL	6	392.0	385.5	419.2	452.9	481.0	32.13
	RWT	6	620.0	583.9	768.3	952.8	1100.0	175.77
21	TL	4	425.0	418.6	460.5	502.4	485.0	26.35
	FL	4	397.0	392.5	430.8	469.0	449.0	24.06
	RWT	4	580.0	527.1	810.0	1092.9	1000.0	177.76
22	TL	2	434.0		437.5		441.0	4.95
	FL	2	404.0		409.0		414.0	7.07
	RWT	2	720.0		740.0		760.0	28.28
23	TL	3	486.0	446.8	510.3	573.9	537.0	25.58
	FL	3	457.0	428.3	478.3	528.4	497.0	20.13
	RWT	3	770.0	464.5	1006.7	1548.8	1200.0	218.25
24	TL	3	415.0	362.1	448.0	534.0	484.0	34.60
	FL	3	388.0	340.5	417.7	494.9	450.0	31.09
	RWT	3	530.0	279.6	670.0	1060.4	840.0	157.16
25	TL	4	415.0	407.3	467.5	527.7	505.0	37.83
	FL	4	387.0	380.4	437.0	493.6	470.0	35.56
	RWT	4	460.0	405.0	840.0	1275.0	1100.0	273.37
30	TL	1			465.0			
	FL	1			434.0			
	RWT	1			720.0			

Total	TL	135	230.0	403.2	412.5	421.9	537.0	54.96
	FL	135	215.0	376.6	385.4	394.3	497.0	51.86
	RWT	135	100.0	577.0	613.5	650.0	1200.0	214.64
	Age	135	4.0	12.0	13.0	13.9	4.0	5.57

Appendix 15. Fork length frequency distributions of angled (AN) and trap net (TN) caught northern pike for Kesagami Lake 1984 to 1995.

FL (min)	FL (max)	1984			1994		1995			
		TN	AN	TN/AN	TN/AN		TN/AN		Guide Measured	
		%	%	%	No.	%	No.	%	No.	%
100	149								1	0.7
150	199								1	0.7
200	249								1	0.7
250	299	0.9		0.7	3	1.9	1	0.5	4	2.9
300	349				1	0.6	5	2.6	3	2.2
350	399	0.9		0.7	2	1.3	5	2.6	18	13.0
400	449	6.7		4.9	2	1.3	5	2.6	9	6.5
450	499	11.1		8.1	10	6.3	15	7.8	18	13.0
500	549	9.7		7.1	8	5.0	19	9.9	6	4.3
550	599	6.7	2	5.4	7	4.4	11	5.7	13	9.4
600	649	5.9	4.1	5.4	7	4.4	20	10.4	8	5.8
650	699	6.7	4.1	6.0	17	10.7	15	7.8	11	8.0
700	749	13.2	24.5	16.2	13	8.2	19	9.9	21	15.2
750	799	11.1	12.2	11.4	12	7.5	11	5.7	2	1.4
800	849	11.1	14.3	12.0	16	10.1	17	8.9	13	9.4
850	899	5.3	10.2	6.6	20	12.6	12	6.3	2	1.4
900	949	3.8	16.3	7.1	20	12.6	16	8.3	4	2.9
950	999	2.9	6.1	3.8	10	6.3	13	6.8	2	1.4
1000	1049	2.9	6.1	3.8	5	3.1	5	2.6	1	0.7
1050	1099	0.9		0.7	4	2.5	3	1.6		
1100	1149				2	1.3				
Total (No. of fish)		134	49	183	159		192		138	

Note: - 1984 - 49 pike angled, 134 trap net and in 1994 - 5 pike were angled, remainder were trap net
- 1984 and 1986 percent frequencies were derived from histograms. Numbers of fish in each class were not available and percent frequencies may be imprecise.

Appendix 16. Mean fork length[a] at age for Kesagami Lake northern pike in 1984 and 1986.

Age frequency distribution and mean fork length at age for northern pike Kesagami Lake 1984.

Age	f(AN)	f(TN)	FL	LCL	UCL
1					
2					
3		4	414.5	335.7	493.3
4		10	465.1	395.4	534.8
5		15	494.7	431.4	558.0
6	4	12	544.6	463.1	626.1
7	6	11	592.2	505.5	678.9
8	10	11	693.6	562.9	824.3
9	4	10	727.2	576.1	878.3
10	8	11	744.2	631.9	856.5
11	1	15	768.3	685.6	851.0
12	2	11	802.2	610.9	993.5
13	7	8	873.0	784.0	962.0
14	3	6	931.8	763.2	1100.4
15	2	2	973.0	778.1	1167.9
16		3	989.7	666.1	1313.3
17		2	1017.0	822.1	1211.9
18					
Total	47	131			

Note: Mean lengths and mortality calculations are based on TN data only.

Age frequency distribution and mean fork length at age for northern pike Kesagami Lake 1986.

Age	f(TN/GN)	f(AN)	f(all)	FL	LCL	UCL
1	1		1	224.0		
2						
3	5		5	421.8	415.9	427.7
4	14	1	15	474.7	464.1	485.3
5	11	2	13	517.2	502.7	531.7
6	9	2	11	574.9	555.4	594.4
7	4	3	7	619.0	601.5	636.5
8	5	6	11	681.4	664.5	698.3
9	6	8	14	690.4	673.4	707.4
10	7	4	11	720.9	703.4	738.4
11	5	7	12	825.3	804.1	846.5
12	5	1	6	786.2	763.7	808.7
13	1	3	4	941.5	925.4	957.6
14	3	1	4	879.7	869.8	889.6
15	2	1	3	873.0	845.1	900.9
16		2	2	953.5	914.9	992.1
17	1	1	2	918.0	872.3	963.7
18						
Total	79	42	121			

Note: Mean lengths and mortality calculations are based on trap net, gill net and angling data combined. Ages are from cleithra.

[a]Mean fork lengths were available for trap net data only in 1984 (Armstrong 1984) and for trap net and angled data combined in 1986 (Hendry and Payne 1986).

Appendix 17. Basic fish attributes collected for trap net captured northern pike, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
2	TL	11	389.0	338.1	367.0	395.9	425.0	42.96
	FL	11	260.0	313.4	341.6	369.8	401.0	41.99
	RWT	11	120.0	201.5	271.8	342.1	450.0	104.67
3	TL	3	484.0	459.0	494.7	530.4	511.0	14.36
	FL	3	451.0	425.6	459.3	493.1	475.0	13.58
	RWT	3	560.0	486.2	600.0	713.5	650.0	45.83
4	TL	10	466.0	490.4	513.4	536.4	574.0	32.19
	FL	10	435.0	457.9	479.1	500.3	537.0	29.58
	RWT	10	560.0	653.7	736.0	818.3	950.0	115.01
5	TL	17	469.0	537.9	562.9	587.9	659.0	48.58
	FL	17	438.0	502.8	526.5	550.2	620.0	46.08
	RWT	17	550.0	843.9	998.2	1152.6	1750.0	300.27
6	TL	21	507.0	599.5	625.5	651.5	721.0	57.08
	FL	21	474.0	561.3	585.9	610.5	679.0	54.05
	RWT	21	720.0	1225.5	1472.4	1719.2	2350.0	542.30
7	TL	25	517.0	676.6	710.1	743.7	832.0	81.33
	FL	25	483.0	636.0	668.2	700.4	780.0	78.06
	RWT	25	670.0	1944.0	2288.8	2633.6	3600.0	835.32
8	TL	24	642.0	730.8	763.9	797.1	942.0	78.48
	FL	24	600.0	687.2	718.5	749.7	883.0	74.02
	RWT	23	1500.0	2413.3	2919.6	3425.8	6750.0	1170.72
9	TL	4	730.0	717.7	755.2	792.8	782.0	23.57
	FL	4	688.0	672.8	711.2	749.6	740.0	24.13
	RWT	4	2450.0	2205.3	2700.0	3194.7	3150.0	310.91
10	TL	8	748.0	808.0	859.8	911.5	951.0	61.84
	FL	8	708.0	761.2	812.4	863.6	909.0	61.26
	RWT	8	2400.0	3496.8	4381.3	5265.7	6050.0	1057.90
11	TL	12	715.0	780.0	845.2	910.4	989.0	102.61
	FL	12	671.0	738.8	802.0	865.1	940.0	99.33
	RWT	12	2050.0	2973.1	4279.2	5585.2	7500.0	2055.50
12	TL	7	810.0	849.2	912.1	975.0	1005.0	67.99
	FL	7	813.0	823.1	873.6	924.0	955.0	54.58
	RWT	7	4300.0	4371.5	5164.3	5957.0	6500.0	857.18
13	TL	12	818.0	888.3	939.8	991.4	818.0	81.14
	FL	13	772.0	849.9	897.5	945.2	772.0	78.92

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
	RWT	13	3550.0	5105.5	6176.9	7248.3	9200.0	1773.00
14	TL	6	762.0	837.2	933.8	1030.4	1003.0	92.05
	FL	7	720.0	818.9	899.4	979.9	965.0	87.05
	RWT	7	3100.0	4489.4	6135.7	7782.1	7750.0	1780.10
15	TL	2	932.0		956.5		981.0	34.65
	FL	2	892.0		915.0		938.0	32.53
	RWT	2	5250.0		5250.0		5250.0	0.00
16	TL	9	882.0	947.9	1005.3	1062.8	11123.0	74.76
	FL	9	850.0	907.2	961.2	1015.3	1075.0	70.30
	RWT	9	4900.0	6536.1	7838.9	9141.3	9500.0	1694.80
17	TL	5	975.0	970.6	1014.6	1058.6	1070.0	35.47
	FL	5	933.0	923.8	974.8	1025.8	1040.0	41.04
	RWT	5	6500.0	5429.8	7740.0	10050.0	11000.0	1860.60
18	TL	2	968.0		977.0		986.0	12.73
	FL	3	910.0	765.3	972.3	1179.4	1067.0	83.34
	RWT	3	7350.0	5683.4	7950.0	10220.0	9000.0	912.41
19	TL	2	990.0		1052.5		1115.0	88.34
	FL	2	950.0		1010.0		1070.0	84.85
	RWT	2	7650.0		8725.0		9800.0	1520.30

Total	TL	182	289.0	708.5	736.1	763.8	1123.0	189.19
	FL	185	**260.0**	673.1	**700.2**	727.2	**1075.0**	186.58
	RWT	184	**120.0**	2906.7	**3283.0**	3659.3	**11000.0**	2587.10
	Age	183	2.0	8.1	8.7	9.4	19.0	4.22

Appendix 18. Basic fish attributes collected for trap net captured lake whitefish, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
4	FL	1			292.0			
5	FL	3	317.0	293.0	331.7	370.3	348.0	15.57
6	FL	4	337.0	298.6	366.7	434.9	430.0	42.80
7	FL	3	369.0	366.2	371.3	376.5	373.0	2.08
8	FL	2	394.0		406.5		419.0	17.68
9	FL	1			399.0			
10	FL							
11	FL	2	400.0		405.0		410.0	7.07
12	FL	1			385.0			
13	FL							
14	FL	4	398.0	381.2	415.0	448.8	446.0	21.26
15	FL	2	392.0		411.5		431.0	27.58
16	FL	3	366.0	312.7	411.3	510.0	440.0	39.72
17	FL	1			429.0			
18	FL							
19	FL	1			457.0			
20	FL	1			422.0			

Total	TL	29	333.0	422.6	439.9	457.2	510.0	45.50
	FL	29	292.0	374.0	389.7	405.3	457.0	41.22
	RWT	29	350.0	799.2	911.6	1023.9	1450.0	295.20
	Age	29	4.0	9.0	10.8	12.6	20.0	4.82

Appendix 19. Basic fish attributes collected for trap net captured lake herring, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
1	FL	5	142.0	141.2	148.6	156.0	157.0	5.94
2	FL	5	176.0	177.1	181.6	186.1	185.0	3.65
3	FL	2	197.0		228.5		260.0	44.55
4	FL	2	237.0		247.5		258.0	14.85
5	FL	5	230.0	229.8	254.8	279.8	282.0	20.09
6	FL	1	260.0		260.0		260.0	
7	FL							
8	FL	5	280.0	278.5	294.0	309.5	312.0	12.49
9	FL	1	291.0		291.0		291.0	
Total	TL	26	158.0	230.7	256.2	281.7	350.0	63.22
	FL	26	142.0	204.3	226.8	249.4	312.0	55.86
	RWT	25	20.0	146.6	196.6	246.6	410.0	121.15
	Age	26	1.0	3.1	4.2	5.3	9.0	2.68

Appendix 20. Basic fish attributes collected for trap net captured longnose sucker, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
5	FL	2	320.0		330.5		341.0	14.85
7	FL	3	340.0	285.4	380.3	475.3	416.0	38.21
8	FL	2	371.0		387.0		403.0	22.63
9	FL	1			428.0			
10	FL	5	388.0	395.6	421.8	448.0	445.0	21.11
11	FL	1			382.0			
12	FL	1			461.0			
13	FL	2	462.0		466.5		471.0	6.36
14	FL	1			429.0			
16	FL	3	425.0	390.7	446.7	502.7	470.0	22.55
17	FL	1			454.0			
18	FL	1			475.0			
20	FL	1			491.0			

Total	TL	24	343.0	430.6	451.4	472.2	530.0	49.21
	FL	24	320.0	400.6	419.9	439.3	491.0	45.86
	RWT	24	440.0	950.1	1096.0	1242.0	1650.0	345.55
	Age	24	5.0	9.6	11.3	13.1	20.0	4.19

Appendix 21. Basic fish attributes collected for trap net captured white sucker, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
2	FL	1			182.0			
6	FL	1			394.0			
7	FL	2	344.0		377.0		410.0	46.67
8	FL	1			365.0			
9	FL	4	377.0	364.3	403.5	442.7	433.0	24.62
10	FL	1			395.0			
11	FL	1			473.0			
12	FL	4	448.0	432.1	462.2	492.4	490.0	18.94
13	FL	5	377.0	374.3	465.6	536.9	530.0	57.46
14	FL	4	405.0	373.1	448.0	522.9	515.0	47.06
15	FL	7	417.0	450.7	490.9	531.0	531.0	43.44
16	FL	5	405.0	395.4	443.2	491.0	490.0	38.49
19	FL	6	427.0	450.0	495.8	541.7	549.0	43.66
20	FL	3	471.0	419.9	515.3	610.8	539.0	38.42
21	FL	1			477.0			

Total	TL	46	193.0	467.6	489.2	510.7	592.0	72.56
	FL	46	182.0	432.3	452.1	471.8	549.0	66.56
	RWT	46	100.0	1201.7	1344.3	1487.0	2300.0	480.44
	Age	46	2.0	12.6	13.8	15.1	21.0	4.27

Appendix 22. Basic fish attributes collected for trap net captured yellow perch, Kesagami Lake 1995.

Age	Attribute	n	Min.	LCL	Mean	UCL	Max.	S.D.
3	FL	1			143.0			
4	FL	9	152.0	159.7	171.2	182.8	197.0	15.00
5	FL	2	170.0		175.0		180.0	7.07
6	FL	4	190.0	170.7	220.2	269.8	250.0	31.12
7	FL	1			227.0			
8	FL	6	222.0	225.4	239.5	253.6	255.0	13.40
9	FL	2	229.0		244.5		260.0	21.92
Total	TL	25	152.0	197.1	213.2	229.2	272.0	38.97
	FL	25	143.0	187.3	187.3	218.2	260.0	37.41
	RWT	25	30.0	96.7	96.7	160.5	280.0	77.35
	Age	25	3.0	5.0	5.8	6.6	9.0	1.93

Appendix 23. Comparison of assessed ages of walleye from scales and dorsal fin spines, Kesagami Lake 1994 and 1995.

Observed frequency

Scale Age	Spine Age																															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Total
1																																	
2		4																															4
3					1																												
4				9																													9
5					25	1																											26
6						36	4	2																									42
7							58	17	2																								77
8							1	86	6	1	3	1																					98
9								1	18	4	8	7	1																				39
10									1	12	14	17	11	6	3	1		1			1			1									68
11											9	13	16	22	5	4		1			4					1							75
12												10	12	25	14	9	3	4	7		3	1	1				2						91
13													6	15	16	7	7	1	7	5	5	3	3	7	2	1		1					86
14															3	6	5	3	8	9	9	2		4	2		1						52
15													1			3	5	3	3	7	17	5	2	10	2	4		1				1	64
16															1	1	2		3	5	14	8	2	3	7	1		1	1				49
17																				1	8	6	2	6	1	2							26
18																			1	1	8	1	2	1	1	2				1			18
19																						1	2	2									5
20																					1	1	1	1									4
21																																	
22																									1			1					
23																																	
24																																	
25																																1	1
Total	0	4	0	9	26	37	63	106	27	17	34	48	47	68	41	31	22	13	29	28	70	28	15	35	16	11	3	4	1	1	0	2	833

Proportion

Scale Age	Spine Age																															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	Total
1																																	
2		1.00																															1.00
3																																	
4				1.00																													1.00
5					0.96	0.04																											1.00
6						0.86	0.10	0.05																									1.00
7							0.75	0.22	0.03																								1.00
8							0.01	0.88	0.06	0.01	0.03	0.01																					1.00
9								0.03	0.46	0.10	0.21	0.18	0.03																				1.00
10									0.01	0.18	0.21	0.25	0.16	0.09	0.04	0.01		0.01			0.01			0.01									1.00
11											0.12	0.17	0.21	0.29	0.07	0.05		0.01			0.05					0.01							1.00
12												0.11	0.13	0.27	0.15	0.10	0.03	0.04	0.08		0.03	0.01	0.01				0.02						1.00
13													0.07	0.18	0.18	0.08	0.08	0.01	0.08	0.06	0.06	0.04	0.04	0.08	0.02	0.01		0.01					1.00
14															0.06	0.12	0.10	0.06	0.15	0.17	0.17	0.04		0.08	0.04	0.00	0.02						1.00
15													0.02			0.05	0.08	0.05	0.05	0.11	0.27	0.08	0.03	0.16	0.03	0.06		0.02				0.02	1.00
16															0.02	0.02	0.04	0.00	0.06	0.10	0.29	0.16	0.04	0.06	0.14	0.02		0.02	0.02				1.00
17																				0.04	0.31	0.23	0.08	0.23	0.04	0.08							1.00
18																			0.06	0.06	0.44	0.06	0.11	0.06	0.06	0.11				0.06			1.00
19																						0.20	0.40	0.40									1.00
20																					0.25	0.25	0.25	0.25									1.00
21																																	
22																																	
23																																	
24																																	
25																																1.00	1.00

age_comp.wq1

Appendix 24. Comparison of assessed ages of walleye from dorsal fin spines and otoliths, Kesagami Lake 1994 and 1995.

Observed frequency

Spine Age	Otolith Age																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total
1																															0
2																															0
3																															0
4				1																											1
5					3		1																								4
6						9																									9
7							22																								22
8								39			1																				40
9									7				1																		8
10									1	5	1																				7
11											2	1	2																		5
12									1		1	16			1																19
13													8	2																	10
14												3	2	20	1	1	1														28
15															9		1														10
16																11	1		1												13
17																1	4	1	2	1											9
18																	1	1		1	1										4
19																		1	1	2	2	1									7
20																				6		2									8
21																1				1	6	2	1	1							12
22																				1		3			1						5
23																							3	1				1			5
24																								3	3	1					7
25																								1	4	1					6
26																															0
27															1																1
28																			1												1
29																															0
30																														1	1
Total	0	0	0	1	3	9	23	39	9	5	5	20	13	22	12	14	8	3	5	12	9	8	4	6	8	2	0	1	0	1	242

Proportion

Spine Age	Otolith Age																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total
1																															
2																															
3																															
4				1.00																											1.00
5					0.75		0.25																								1.00
6						1.00																									1.00
7							1.00																								1.00
8								0.98			0.03																				1.00
9									0.88				0.13																		1.00
10									0.14	0.71	0.14																				1.00
11											0.40	0.20	0.40																		1.00
12									0.05		0.05	0.84			0.05																1.00
13													0.80	0.20																	1.00
14												0.11	0.07	0.71	0.04	0.04	0.04														1.00
15															0.90		0.10														1.00
16																0.85	0.08		0.08												1.00
17																0.11	0.44	0.11	0.22	0.11											1.00
18																	0.25	0.25		0.25	0.25										1.00
19																		0.14	0.14	0.29	0.29	0.14									1.00
20																				0.75		0.25									1.00
21																0.08				0.08	0.50	0.17	0.08	0.08							1.00
22																				0.20		0.60			0.20						1.00
23																							0.60	0.20				0.20			1.00
24																								0.43	0.43	0.14					1.00
25																								0.17	0.67	0.17					1.00
26																															
27															1.00																1.00
28																			1.00												1.00
29																															
30																														1.00	1.00

age_comp.wq1

Appendix 25. Comparison of assessed ages of northern pike from scales and pectoral fin rays, Kesagami Lake 1994 and 1995.

Frequency

Scale Age	Fin Ray Age																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	**Total**
1	1	1																		2
2		10		1																11
3			8	1																9
4				9	4	1														14
5				5	26	10	1													42
6					4	16	5	6	1											32
7				1		3	22	6	1	1	1									35
8					1		5	14	3	5	3	1								32
9								5	6	7	6	4	1	1						30
10										6	10	7	5		1	2				31
11										1	9	5	6	2	2	1	1			27
12											1	7	7	4	2	1	1	1		24
13												3	2	1		6	2	1	1	16
14												1	3	1	1	3	1	1	1	12
15													1	5		7	2	2		17
16																3				3
17																	1	1	1	3
Total	1	11	8	17	35	30	33	31	11	20	30	28	25	14	6	23	8	6	3	340

Proportion

Scale Age	Fin Ray Age																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
1	0.5	0.5																		1
2		0.91		0.09																1
3			0.89	0.11																1
4				0.64	0.29	0.07														1
5				0.12	0.62	0.24	0.02													1
6					0.13	0.5	0.16	0.19	0.03											1
7				0.03		0.09	0.63	0.17	0.03	0.03	0.03									1
8					0.03		0.16	0.44	0.09	0.16	0.09	0.03								1
9								0.17	0.2	0.23	0.2	0.13	0.03	0.03						1
10										0.19	0.32	0.23	0.16		0.03	0.06				1
11										0.04	0.33	0.19	0.22	0.07	0.07	0.04	0.04			1
12											0.04	0.29	0.29	0.17	0.08	0.04	0.04	0.04		1
13												0.19	0.13	0.06		0.38	0.13	0.06	0.06	1
14												0.08	0.25	0.08	0.08	0.25	0.08	0.08	0.08	1
15													0.06	0.29		0.41	0.12	0.12		1
16																1				1
17																	0.33	0.33	0.33	1

Appendix 26. Age-length key for Kesagami Lake northern pike 1994 and 1995.

Frequency

FL (min)	FL (max)	Age																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
50	99																					
100	149																					
150	199																					
200	249																					
250	299	2	1																			
300	349		5																			3
350	399		5	2																		5
400	449		1		3	3																7
450	499			5	12	4	3	1														7
500	549			1	1	15	6	2														25
550	599					6	7	3		1												17
600	649				1	2	10	8	5					1								27
650	699					2	6	6	8	5	1	3		1								32
700	749							7	12	2	5	5			1							32
750	799							6	2	0	4	5	5	1								23
800	849								3	1	7	5	10	4	1		1				1	33
850	899					1			2	2	1	6	7	6	1	2	3	1				32
900	949										3	7	5	5	6	2	4	2	2			36
950	999												1	6	5		6	4		1		23
1000	1049													1			7	1		1		10
1050	1099															1	1		4	1		7
1100	1149															1	1					2
1150	1199																					0
Total		2	12	8	17	33	32	33	32	11	21	31	28	25	14	6	23	8	6	3	1	346

Proportion

FL (min)	FL (max)	Age 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
50	99																					
100	149																					
150	199																					
200	249																					
250	299	0.67	0.33																			1
300	349		1.00																			1
350	399		0.71	0.29																		1
400	449		0.14		0.43	0.43																1
450	499			0.20	0.48	0.16	0.12	0.04														1
500	549			0.04	0.04	0.60	0.24	0.08														1
550	599					0.35	0.41	0.18		0.06												1
600	649				0.04	0.07	0.37	0.30	0.19					0.04								1
650	699					0.06	0.19	0.19	0.25	0.16	0.03	0.09		0.03								1
700	749							0.22	0.38	0.06	0.16	0.16			0.03							1
750	799							0.26	0.09		0.17	0.22	0.22	0.04								1
800	849								0.09	0.03	0.21	0.15	0.30	0.12	0.03		0.03				0.03	1
850	899					0.03			0.06	0.06	0.03	0.19	0.22	0.19	0.03	0.06	0.09	0.03				1
900	949										0.08	0.19	0.14	0.14	0.17	0.06	0.11	0.06	0.06			1
950	999												0.04	0.26	0.22		0.26	0.17		0.04		1
1000	1049													0.10			0.70	0.10		0.10		1
1050	1099															0.14	0.14		0.57	0.14		1
1100	1149															0.50	0.50					1
1150	1199																					
Total																						18

Appendix 27. Fulton condition factors for northern pike and walleye, Kesagami Lake 1994 and 1995.

1994								
Species	**FL**	**n**	**min.**	**LCL**	**mean**	**UCL**	**max.**	r^2
Northern Pike	<600	33	5.85	7.23	7.79	8.34	11.64	0.004
	600-799	49	5.64	7.63	8.01	8.38	11.23	0.009
	>799	75	5.27	7.99	8.32	8.65	14.02	0.019
	Total	157	5.27	7.88	8.11	8.34	14.02	0.0212*
Walleye	**Total**	341	6.25	10.46	10.60	10.74	14.91	-0.0045*

Note: Calculated as (RWT(g)/FL(mm)^3)*1000000.
Value of r^2 for regression of condition factor on FL; regression is significant (*) for all walleye and northern pike ($p<0.05$), but not within each length class.

1995								
Species	**FL**	**n**	**min.**	**LCL**	**mean**	**UCL**	**max.**	r^2
Northern Pike	<600	61	4.92	6.36	6.51	6.66	7.82	-0.020
	600-799	64	4.74	7.27	7.47	7.66	9.14	0.002
	>799	66	5.19	7.95	8.20	8.44	10.16	0.010
	Total	191	4.74	7.26	7.41	7.56	10.16	0.37*
Walleye	**Total**	511	7.75	10.10	10.17	10.24	13.88	-0.001

Note: Calculated as (RWT(g)/FL(mm)^3)*1000000.
Value of r^2 for regression of condition factor on FL; regression is significant (*) for all northern pike ($p<0.05$), but not within each length class.

Appendix 28. Functional regressions between fork length and round weight for northern pike and walleye, Kesagami Lake 1994 and 1995.

1994						
Species	**X**	**Y**	**a**	**b**	**r^2**	**n**
Northern Pike	FL	TL	1.029	18.860	0.999	157
	log(FL)	log(RWT)	3.149	-5.524	0.964	157
	log(TL)	log(RWT)	3.228	-5.826	0.964	155
Walleye	FL	TL	1.062	4.276	0.993	344
	log(FL)	log(RWT)	2.966	-4.892	0.884	341
	log(TL)	log(RWT)	2.988	-5.038	0.883	342

1995						
Species	**X**	**Y**	**a**	**b**	**r^2**	**n**
Northern Pike	FL	TL	1.028	21.048	0.999	188
	log(FL)	log(RWT)	3.312	-6.017	0.985	191
	log(TL)	log(RWT)	3.407	-6.373	0.984	188
Walleye	FL	TL	1.056	5.450	0.998	511
	log(FL)	log(RWT)	3.031	-5.075	0.974	511
	log(TL)	log(RWT)	3.063	-5.245	0.974	511

Appendix 29. Kolmogorov-Smirnov test statistics and p-values for comparisons of walleye and northern pike fork length frequency distributions, Kesagami Lake 1994-1995. P-value of <0.05 indicates a significant difference between distributions.

Northern Pike	1994	1995	1995(guide)
1994			
1995	0.17 1.13		
1995 (guide)	0.39 0.00	0.24 0.0002	

Key:

K-S Stat. p value

Walleye		1994		1995	
		TN	AN	TN	AN
1994	TN				
	AN	0.05 1.00			
1995	TN	0.25 0.00	0.28 0.00		
	AN	0.04 1.00	0.05 1.00	0.24 0.00	
Note: Comparisons were not done with 1984 and 1986 data as raw frequency distributions were not available.					

Appendix 30. Water chemistry statistics for Kesagami Lake Provincial Park 1995.

Station Number	Dates Surveyed	Maximum depth (m)	Temperature		Dissolved Oxygen	
			Min. °C	Max. °C	Min. mg/L	Max. mg/L
01	July 2 - Aug 8	7.5	9.4	21.0	7.5	9.4
02	June 27 - Aug 8	3.5	17.0	22.0	8.0	9.4
03	June 26 - Aug 13	3.5	16.0	19.5	7.6	9.7
04	June 27 - Aug 13	3.0	15.0	22.5	7.6	9.6
05	June 26 - Aug 9	3.0	15.6	21.3	8.0	10.2
06	June 26 - Aug 9	3.0	15.1	20.2	8.3	9.2
07	June 25 - Aug 10	2.5	15.9	21.0	8.1	10.0
08	June 30 - Aug 10	2.5	16.5	21.5	8.3	10.1
09	July 2 - Aug 13	2.5	16.0	21.8	8.0	9.1
10	June 26 - Aug 9	1.3	15.6	22.3	8.0	9.4
11[a]	June 26 - Aug 9	1.2	15.9	23.0	8.1	11.0
12	June 26 - Aug 9	3.0	16.9	22.5	8.0	9.7

[a]Only station #11 showed maximum temperature of 23.0°C which is within the critical range for northern pike.

Appendix 31. Bird observations Kesagami Lake 1995.

Date	Species[a]	Comment	Observer
95-05-25	CAGO	3 flocks flying north	creel crew
95-05-25	OSPR	2 flocks flying north	creel crew
95-06-01	OSPR	1 flock flying north	creel crew
95-06-02	CAGO	120 flying north	creel crew
95-06-02	OSPR	nest on island at grid 14M	creel crew
95-06-04	BAEA	sighted west shore Ligigami Bay (grid LH)	creel crew
95-06-05	OSPR	2 flying off point	creel crew
95-06-05	CAGO	100 at grid 16H	creel crew
95-06-05	COLO	several on lake	creel crew
95-06-06	CAGO	flock over campsite	creel crew
95-06-08	CAGO	3 flocks over campsite	creel crew
95-06-09	CAGO	2 flocks over campsite	creel crew
95-06-12		few broad billed diving ducks have been seen	creel crew
95-06-12	CANV	1 seen	creel crew
95-06-13	CAGO	40 over lodge at 2100h	creel crew
95-06-15	OSPR	1 at end of Newnham Bay	creel crew
95-06-17	CAGO	1 flock flew over at 1200h	creel crew
95-06-17	DCCO	3 on Gull Island	creel crew
95-06-17	OSPR	1 with large walleye over Gull Island	creel crew
95-06-20	MALL	female with 6 yng at S end	creel crew
95-06-23	OSPR	active nest, 2 flying nearby; 3 more at Manido Island	creel crew
95-06-20		hatched gull next; chicks white W/black spots, 5" long	creel crew
95-06-20	CAGO	about 40 flew over	creel crew
95-06-25	GTBH	2 flew off dock at 220h	creel crew
95-07-09	GOEA	seen at outlet	creel crew
95-07-16	ABDU	female with 9 yng grid 19N	creel crew
95-07-26	BAEA	imm. eating white sucker in Kentucky Bay	creel crew
95-07-29	BAEA	over campsite at 600h	creel crew
95-08-03	SPGR	4 seen grid 19K	creel crew
95-08-05	GOEA	saw it catch a fish	creel crew
95-08-03	ABDU	5 seen grid 17P	creel crew
95-08-09	GOEA	seen at grid 10I	creel crew
95-08-07		merganser female with 20 yng grid 16P	creel crew

[a]Species codes follow first four letters for single name species and the first two letters of each word for double name species. Great Blue Heron (GTBH) and American Black Duck (ABDU) are also represented.

Appendix 32. Mammal observations Kesagami Lake 1995.

Date	Species[a]	Comment	Observer
95-06-29	BLBE	seen on shore	angler
95-07-05	MINK	swimming to island 19L	creel crew
95-06-12	CARI	track on beach near dock, swam narrows	creel crew
95-06-13	CARI	at camp while creeling	creel crew
95-06-18	CARI	seen at camp 2130h	creel crew
95-06-23	CARI	no antlers, on shore grid 28M	creel crew
95-06-29	CARI	cow and calf swimming grid 10H and 10I	creel crew
95-07-13	CARI	cow (no antlers) and calf grid 28N	creel crew
95-07-24	CARI	bull at chem. stn. 1; laying in water	creel crew
95-07-27	CARI	campsite in evening; pawed hole on beach	creel crew
95-07-28	CARI	cow with antlers and calf in water at camp 2150h	creel crew
95-07-29	CARI	at camp 0130h; pawed holes at beach/washroom	creel crew
95-07-29	CARI	yng bull on beach; 20 cm antlers; 0700h and 2130h	creel crew
95-07-30	CARI	same cow as 28th pawing around washroom	creel crew
95-07-30	CARI	bull across narrows running south	creel crew
95-08-01	CARI	same cow as 30th around camp; 2130h	creel crew
95-08-04	CARI	same cow as 1st at camp; morning and evening	creel crew
95-08-06	CARI	large bull across narrows	creel crew
95-08-07	CARI	large bull grid 10I	creel crew
95-08-09	CARI	large bull on beach grid 16P	creel crew
95-08-13	CARI	cow at camp	creel crew

[a]Species codes follow first four letters for single name species and the first two letters of each word for double name species.

Appendix 33. Wildlife observations reported by the 1994 creel crews located at Kesagami Lake.

Date	Wildlife Observed	Comments[a]	Observer
94.06.10	Caribou	One bull caribou seen trotting down shoreline beside camp at 22:45.	Robin Stewart
94.06.13	Caribou	Report of a cow and calf swimming by Pickerel Point.	Reported to Robin Stewart
94.06.13	Herring Gull	A total of 14 nests were found on Bird Island. Ten nests had 3 eggs, 2 nests had 2 eggs and 2 nests had 1 egg.	Robin Stewart
94.06.19	Caribou	Report of a caribou walking on shore near lodge.	Robin Stewart
94.06.22	Double-crested cormorant	Two seen on Bird Island.	Robin Stewart
94.06.22	Herring Gull	Newborn herring gull chick photographed on Bird Island.	Robin Stewart
94.06.24	Eagle	Bald or golden eagle photographed on east shore of Otter Bay.	Robin Stewart
94.06.25	Caribou	Report of 4 caribou walking along east shore of Kochichi Bay.	Reported to Robin Stewart
94.06.25	Osprey	Found an active osprey nest on North Point of Big Island.	Robin Stewart
94.06.27	Eagle	Saw bald or golden eagle on Black Spruce on northshore of Outlet Bay.	Robin Stewart
94.06.30	Caribou	One seen on Big Island along the south shore.	Bob Florean
94.06.30	Caribou	One observed on Big Island by angler and considered different from the caribou above.	Reported to Bob Florean
94.07.03	Caribou	Saw young caribou - possibly a yearling near east side of South Bay.	Bob Florean
94.07.07	Caribou	Two caribou (one was a large bull) seen on shore opposite south shore of Big Island.	Bob Florean
94.07.27	Caribou	Saw cow and calf at P16 and P17 walking in forest.	Robin Stewart
94.07.28	Caribou	Report of a cow and a calf swimming in Ligigami Bay by angler.	Reported to Robin Stewart
94.07.28	Bald Eagle	Two adult bald eagles reported near Pickerel Point by angler.	Reported to Robin Stewart
94.08.15	Osprey	One nest reported at north tip of Big Island on the west side.	Steve Scholten

[a]Locations used in text are as follows; Pickerel Point (N16), Bird Island (M10), Otter Bay (Ligigami Bay), Outlet Bay (Kochichi Bay), South Bay (Bay south of Big Island).